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SECTION A

INVITED PAPERS

ECONOMIC EDUCATION AND THE PUBLIC POLICY PROCESS
What Can Economists Do?*

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John Maynard Keynes stated that the world is ruled by little else than the ideas of economists and political philosophers (Keynes, 1936:383). Although Lord Keynes may have overstated the case for economic education, there is a great deal of evidence that ideas have consequences in economic policy, just as they do in other areas (Weaver, 1948). Even among economists, however, there is sharp disagreement concerning the potential for economic education. On the one side is the conventional view that economic research and education can make an important contribution to public policy. In sharp contrast, a recent view that the Virginia School of public choicers in the United States have labeled Chicago Political Economy argues that government programs that survive politically are superior to available alternatives (Mitchell, 1989). It is shown below that there appears to be no scope for beneficial economic analysis in this extreme version of positive political economy and, consequently, no productive role for the economist in the public policy process.

What can economists contribute to public policy? It is argued below that the answer given to the question is heavily

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influenced by one's view of how well market and political processes work. The general approach of this paper is to contrast the public policy implications of traditional welfare economics, conventional public choice theory, and "Chicago Political Economy." First, the traditional "market" failure approach is reviewed and the implications of Coasean transactions costs explored both for economic theory and for public policy analysis. Second, the traditional welfare economics approach is contrasted with the Virginia public choice or "government failure" approach and the implications of public choice theory analyzed for economic education. Chicago Political Economy is then described and its implications explored for the role of the economist in the public policy process. Finally, the paper assesses the overall potential for the economist in the public policy arena.

Economists and Public Policy--The Traditional View

The conventional view is that economists have an important role to play in public policy. Indeed, the conclusion that there is ample scope for improvement in public policy and, hence for economic education, follows regardless of whether one holds a "market failure" or a "government failure" view of the political and economic system.

Market Failure and Transactions Costs

Conventional welfare economics emphasizes the importance of "market failures" in the form of externalities, public goods,

monopoly, imperfect information, and so on. Market failures abound, of course, when real-world markets are measured against the norm of perfect competition, which is characterized by price-taking behavior and perfect markets, with perfect communication, instantaneous equilibrium, and costless transactions. However, there is increasing recognition among economists that market failure identified in this way, labeled by Demsetz (1969) as the "nirvana approach," has no significance for public policy.[1] Real world markets will always fall short if measured against a norm in which decision makers are assumed to have perfect knowledge about all relevant variables. Indeed, as shown below, when transactions costs are taken into account, economic analysis has yet to develop a reliable system for identifying externalities and other examples of market failure that have relevance for public policy.

A.C. Pigou (1962) generally is credited with being the first to formalize the concept of an externality and much of this literature today reflects the Pigouvian influence.[2] A Pigouvian externality arises whenever there is a difference between private costs and social costs. In the Pigouvian approach where the extent of the spillover is assumed to be known, it is easy to internalize externalities by imposing a per-unit tax equal to the

[1]"In practice, those who adopt the nirvana viewpoint seek to discover discrepancies between the ideal and the real, and if discrepancies are found, they deduce that the real is inefficient" (Demsetz, 1969:1).

[2]However, Samuelson apparently coined the term "externality" (Coase, 1988:23).

difference between marginal private cost and marginal social cost.

Such an analysis, however, is what Nobel Laureate Ronald Coase refers to as "blackboard economics" (Coase, 1988:19). The policy used to internalize the externality is implemented on the blackboard.[3] All the information needed is assumed to be available and the teacher prescribes what is necessary to reach this ideal state without much consideration either of how it is to be done or of the problems confronted in doing so. The analysis is carried out with great ingenuity but, as Coase (1988:28) emphasizes, it "floats in the air." There is no counterpart to the teacher in the real economy, no one who has access to such information, and no one entrusted with the task performed on the blackboard. Although blackboard economics plays an important role in developing the skills of an economist, Coase suggests that this approach misdirects attention when thinking about economic policy.

The Pigouvian approach in welfare economics tends to assume omniscience on the part of the observing economist (Buchanan, 1987:5). However, there may be little or no relationship between the costs and benefits estimated by the outside observer and the evaluations that individuals place on alternatives in actual choice situations. And, if the data upon which choices are based

[3]"...such tax proposals are the stuff that dreams are made of. In my youth it was said that what was too silly to be said may be sung. In modern economics it may be put into mathematics" (Coase, 1988:185).

cannot be obtained, marginal efficiency conditions in blackboard models are of little prescriptive use for public policy.

In public policy analysis in the Pigouvian world, transactions costs are not an important consideration because information problems tend to be assumed away. However, Coase (1988) shows that transactions costs are highly important in studying the world that actually exists. Consider the example of a spillover in the form of soil erosion, which pollutes streams. Market failure carries with it the connotation that the government should intervene to eliminate it. However, a divergence between private cost and social cost provides no decisive justification for government action. Indeed, the costs of intervention in the United States frequently have been found to outweigh the benefits.[4] The reason that individuals and private organizations do not eliminate soil erosion and other spillovers is that the perceived gain would be more than offset by what would be lost in doing so. And if with government intervention the losses exceed the gains, the spillover should remain. Moreover, as Coase emphasizes, the transactions costs of making the arrangements necessary to bring about the results are properly included in the calculations of costs and benefits. But if such costs are included, it cannot be proven that "market

[4]"The ubiquitous nature of "externalities" suggests to me that there is a prima facie case against intervention, and the studies on the effects of regulation that have been made in recent years in the United States, ranging from agriculture to zoning, which indicate that regulation has commonly made matters worse, lend support to this view" (Coase, 1988:26).

failure" exists in the sense that government action is warranted (Dahlman, 1979)! In other words, given the institutional constraints, that which exists is the best that can be done is a logical implication of the axioms of rational behavior (Crew and Rowley, 1988:54).

The fact that economists cannot identify examples of market failure in this sense, of course, does not suggest that we are in a Panglossian world. There is ample reason to think that superior political and institutional arrangements are possible, just as there is scope for entrepreneurship in the market process (Kirzner, 1973). Whereas the conventional approach in welfare economics is to consider an ideal economic system and then prescribe what is necessary to achieve this ideal state without much attention given as to how this might be done, a recognition of the importance of transactions costs suggests a quite different emphasis for economic analysis. Economic policy involves a choice between alternative social institutions, which are created by law or are dependent on it. Without knowledge of what could be achieved under alternative institutional arrangements, it is impossible to choose wisely among them (Coase, 1988:30). This suggests that the emphasis of economic analysis in public policy work should be changed--in the Coase approach, economists would devote more attention to the effects of alternative institutional arrangements. This approach is consistent with classical economics where the primary objective of political economy was to contrast alternative political and

economic frameworks in order that choice among those institutional arrangements might be better informed (Buchanan, 1989; 1991). What are the implications for public policy? The economist following the Pigouvian approach in the analysis of market failure problems is likely to prescribe government action where none is warranted because the method has an implicit bias toward interventionist solutions (Burton, 1978:90).

In analyzing spillover and other market failure problems, it is important to consider the costs of alternative institutional arrangements, including transactions costs. Coase's analysis suggests that government should first attempt to make sure that property rights are clearly defined and actively enforced as a means of reducing transactions costs that prevent parties from reaching agreements. The advantage of this property rights approach is that it harnesses economic incentives and uses the price system as a way of generating and utilizing information (Shand, 1990:86). Property transactions near airports, hog farms, and other sources of pollution in the United States show that noise and odors are reflected in housing values. In such cases, lower housing prices may compensate homeowners for the spillovers and, at the same time, provide information about their assessment of these costs.

Again, the focus of the Coasean approach is on alternative institutional arrangements. Another advantage of a market-oriented property rights approach is that it avoids bureaucratic administrative complexities of the political system. It is

significant that conventional welfare economics traditionally has emphasized problems in the operation of markets while largely ignoring similar problems that plague the political process. Stated differently, Pigouvian welfare economics has emphasized market failure while largely ignoring government failure.

Government Failure and Public Choice Theory

Public choice theory involves the use of economic principles to explain decisions in the political process. This extension of neoclassical price theory from market transactions to the political process emphasizes that "government failure" is the analogue of "market failure." As indicated above, markets inevitably "fail" when measured against the norm of perfect competition. Public choice theory demonstrates that government failure is fully predictable too when the performance of political institutions is measured against the norm of a perfect polity. Of course, the touchstone of a perfect polity is no more realistic than that of the perfect market. Thus, the relevant comparison in public policy considerations is that of markets and governments, as each operates under real-world conditions of uncertainty and costly information. Economists can make an important contribution to public policy by providing information on alternative institutional arrangements and, more specifically, by applying public choice insights to the political process.

Information Problems

Government failure is rooted in information and incentive problems. Information problems are endemic in the political process because of the separation of power and knowledge. Frank Hahn, in a recent article in The Economic Journal speculates on possible changes in economics over the next century and urges a redirection of economic analysis. He deplores the widespread use of a theory in which the economy is to be understood as the outcome of the maximization of a representative agent's utility over an infinite future;[5] Hahn urges renewed attention to the central question of economics, that is, how decentralized choices interact and perhaps get coordinated. This approach is consistent with the view of F.A. Hayek (1986) that the basic function of economics is to explain the process through which human activity adapts itself to data about which it has no information. In Nobel Laureate Hayek's classic article, "The Use of Knowledge in Society," he emphasizes the importance of the informational aspects of the decentralized market system (Hayek, 1945). There he stresses that market prices coordinate and transmit information to actual and potential market participants more completely and accurately than can be done through central direction.

A central theme of Hayek's work is the idea of the market system as a "spontaneous order" that is a product of human action but not of human design. In this system that evolved over time,

[5]"It is the last twitch and gasp of a dying method. It rescues rational choice by ignoring every one of the questions pressing for attention" (Hahn, 1991:49).

the development of which was largely unplanned, knowledge is highly fragmented and any member of society can have only a small fraction of the knowledge possessed by all (Hayek, 1979). The focus of Hayek's attention in "The Use of Knowledge in Society" was to ensure that existing dispersed knowledge, much of it highly specialized to time and place, be fully utilized. A generation later he emphasized that the fundamental problem in economic coordination involves not just the utilization of existing knowledge but also the problem of how to elicit implicit and not yet fathomed knowledge. Hayek stresses the uniqueness of the market as a discovery process in the generation of knowledge that none of the participants yet possess (Hayek, 1978; Bartley, 1990:65).

The Hayekian insights concerning the importance of the entrepreneurial market process in the discovery and transmission of information throughout the economy have been either heavily discounted or ignored in public policy. Information problems are endemic in the political process because those with the political power do not have and cannot obtain much of the information that is generated and conveyed through market signals.

The information or knowledge problem was the central issue in the "economic calculation debate" that occurred during the period between World War I and World War II (Hayek, 1948; Lange and Taylor, 1938). In the early 1900s, socialist theorists proposed to replace markets with central planning as the primary means of resource allocation. In 1920, however, Ludwig von Mises

showed that the structure of production in a socialist system cannot reflect consumer wants efficiently because of information problems (Mises, 1951). More generally, the calculation debate demonstrates that the structure of production cannot adapt efficiently to people's wants in the absence of private property and the information and incentives conveyed through competitive market prices (Wagner, 1989). The lesson of the calculation debate is receiving belated recognition, even by former proponents of socialism, following the recent dramatic failure of collectivism as a means of coordinating economic activity in Eastern Europe and the former Soviet Union (Heilbroner, 1990).

The calculation debate is a striking example illustrating the importance of economic education--or, perhaps more accurately, the importance of ignoring economic education. It is difficult to overstate the importance of the Hayek-Mises thesis concerning the significance of a private property order in promoting production and in protecting individual liberties. If this lesson had been learned in the 1920s and 1930s, some of the misery associated with the socialist "experiment" that dominated much of the twentieth century might have been avoided.[6] This costly experiment in collectivism was aided and abetted by the implicit or explicit support of "market socialism" by many, perhaps most, economists who failed to realize the significance

[6]Boris Yeltsin reportedly has remarked that it is unfortunate that the communist experiment occurred in the Soviet Union rather than in a small country, where the associated suffering would have been much less.

of the Hayek-Mises contribution.[7] Market socialism is an oxymoron and should be relegated to the same category in which Solzhenitzyn places democratic socialism, namely "fried snowballs" (cite from Shand, 1990:93).

The Hayekian insight concerning the unique role of decentralized markets in the discovery, coordination, and transmission of information throughout the economy also has implications for economic education in many other contexts. In the allocation of land resources, for example, administrative land use controls as a method of determining land use face information problems similar to those emphasized in the calculation debate. In short, there is no feasible substitute for decentralized market prices as a means of discovering and communicating information throughout the economic system.

Incentive Problems

Even if decision makers in the political process were omniscient, however, they are likely to be dissuaded from acting

[7]The implications of the Mises-Hayek insights apparently were not recognized even at the University of Chicago. Oscar Lange, a central figure in the calculation debate and a leading proponent of "market socialism", was appointed to a position in the Economics Department at the University of Chicago in the 1930s. In his discussion of the history and meaning of Chicago economics, Reder, referring to Lange's appointment, states: "His work on the use of the price system to allocate resources in a socialist economy was widely considered to be a definitive answer to the Mises-Hayek attack on the economic efficiency of socialism..." (Reder, 1982:4)

Buchanan (1991b:17-18) raises an important question for the economics profession: "Why did so many professionals in choice analysis fail to recognize the informational requirements of a centrally controlled economy in both the logical and empirical dimensions?"

to further the common good because of incentive problems. There is a separation of power and responsibility on the part of decision makers in the collective choice process. Voters, legislators, and agency decision-makers with the power to make changes do not bear the consequences of their actions--at least not to the same extent as decision-makers who are residual claimants.

Public opinion polls reveal that most individual voters are poorly informed about many issues that they vote on. This lack of information on the part of the electorate is easily explained on the basis of narrowly defined costs and benefits. The costs of informed voting, especially in terms of time, are substantial but the benefits as measured by the likely effect on the outcome of the election are nil. For example, the probability of getting killed while driving to the voting booth in the United States, even where we drive on the right side of the road, is greater than the likelihood that one's vote will be decisive in the outcome of the election! Since it doesn't pay to be politically informed and active, at least in terms of narrowly defined returns, it should not be surprising that many voters choose to remain "rationally ignorant."

Decision-makers in government agencies, lacking information on available resources, production opportunities, and consumer preferences necessary to determine actions that are in the "public interest," must choose some other goal such as staying in power and/or agency growth. A government agency may attempt to

increase quantity demanded of its services both by advertising and by reducing prices of services offered. It is no accident that most government agencies have well-funded public relations departments and that prices charged are well below costs of providing goods and services.

A government agency also can extend its jurisdiction to justify its existence and to obtain increased appropriations. Agricultural agencies in the United States, such as the Cooperative Extension Service, for example, have broadened their mandates to include non-farm people as the numbers of the original clientele, namely farmers, decreased (Pasour, 1990). Such actions give rise to what has been called the "law of bureaucratic inertia"--government programs set in motion tend to stay in motion. This raises a question about the motives of decision makers in government.

The Pigouvian analysis of traditional welfare economics takes what Paul Heyne has characterized as the "genie" approach to government regulation. It assumes that decision makers in the collective choice process, being imbued with supernatural power like Aladdin's magical lamp, have both the knowledge and the desire to act in ways that promote the public weal. That the relevant knowledge cannot be obtained for comprehensive "social" planning was established in the calculation debate. The latter assumption concerning the motives of political decision makers also deserves emphasis. An implicit assumption of the Pigouvian analysis is that the political actors in government who devise

market-correcting measures are what John Burton (1978:81) refers to as "economic eunuchs." That is, they are assumed to act solely to maximize social efficiency without regard to their own utility, power, prestige, income, or vote appeal.

The success of special interest groups in obtaining preferential legislation at the expense of the public at large is evidence that policy makers are not selfless automatons. Public choice theorists in the United States have devoted considerable effort during the past ten to twenty years to explain this widespread phenomenon in which individuals and groups, including farmers, steel workers, auto workers, and so on, successfully distort the political process for private gain.

Rent seeking is one explanation for special interest legislation. "Rent seeking" is a term used to describe resource-wasting activities that occur as individuals and groups seek income transfers through the aegis of the state (Buchanan, Tollison, and Tullock, 1980).[8] In the United States, for example, huge amounts of time and money are spent in lobbying, campaign contributions, and so on, by farmers, teachers, the auto industry, the steel industry, and other groups in attempts to restrict competition and raise prices through political power. Such efforts are wasteful from the societal point of view because valuable resources are diverted from the production of goods and

[8]The problem of determining rent-seeking activity, a type of economic inefficiency, warrants more attention than it has received. The economic analyst faces problems in isolating examples of rent-seeking that are similar to those confronted in identifying other cases of economic inefficiency (Pasour, 1987).

services to socially non-productive activities whose only purpose is to obtain a larger share of the economic pie. Rent seeking biases the perspective of elected government officials as they cater to groups seeking policies that benefit the few at the expense of the many.

Consider the sugar program in the United States. There are fewer than 10,000 domestic sugar producers and yet sugar interests there maintain a program that increases domestic sugar prices considerably above world price levels. It has been estimated that the benefits per producer are on the order of $200,000 per year (assuming that sugar producers receive all of the benefits). However, the cost of the program to a typical family is less than $100 per year. Thus, it isn't surprising that producers exert more time and money to influence the political process. Nor should it be surprising that the sugar program with highly concentrated benefits and widely diffused costs is maintained despite widespread criticism by virtually all dispassionate observers.

Rent seeking is but one example illuminated by public choice theory that suggests that there is ample scope to make improvements in the political process. And it is notable that J.M. Keynes and F.A. Hayek, though occupying little common ground on public policy, agree that the power of vested interests is vastly exaggerated when compared with the gradual encroachment of ideas (Keynes, 1936:383; Hayek, 1991:17). Recently, however, a variant of the Chicago School of Economics has challenged this

traditional and widely held view that economists can have a favorable impact on public policy.

Chicago Political Economy--No Scope for Economic Education? [9]

Chicago political economy, hereafter referred to as CPE, is a positivist approach that uses price theory in analyzing governmental activity. In CPE the state is a mechanism used by rational economic agents, including individuals and their associations, to redistribute wealth. CPE analysts contend that there is little or no slack in the degree to which constituency interests are represented by democratic institutions.

The conclusion that the political process is efficient is supported by an impressive array of studies contributing to this Chicago version of public choice theory.[10] Important contributions have been made by Becker (1976, 1983, 1985), Peltzman (1984, 1990), Wittman (1989) and, most notably, by Nobel Laureate George Stigler (1982a, 1982b, 1988).

Peltzman (1990:63) implies that support for an "efficient voting hypothesis" is just as strong as that for the efficient market hypothesis in financial markets. However, the level of efficiency attributed to the political process in CPE varies,

[9]This section draws from Pasour (1992a and 1992b).

[10]Much of the work done by members of the Chicago School of Economics is not consistent with the CPE efficient view of the political process. The works of Coase (1988), Friedman and Friedman (1980), and Schultz (1979), for example, are much more compatible with Virginia public choice theory and have implications for the role of economic education in the public policy process that are much different from those of CPE.

just as the level of efficiency in capital markets is assumed to vary, depending upon the form of the efficient market hypothesis. In the most common and "weak" form of CPE, government programs that survive are considered to be relatively efficient in the sense that they are better than available alternatives--that is, the deadweight costs are lower. However, there appears to be little or no scope for economic research and education in public policy, even in this relatively weak form of efficiency in the political system. If there is no superior available alternative to a current government program, how can public policy be improved?

Nobel Laureate Stigler appears to subscribe to an even stronger view of political efficiency. Elected and appointed officials are assumed to be driven by political constraints rather than by their own preferences so that there is no slack in the collective-choice process. Consequently, efficiency in the polity for Stigler appears to be analogous to the "strong" form of efficiency in capital markets, which holds that stock prices fully reflect <u>all</u> information, public and private. In Stigler's words, "...if we look at any important economic policy of the state, we shall find that it takes account of whatever established knowledge economists possess..." (1982b:14).

The implications of this strong form of CPE for contributions by economists to public policy are manifest. When economists purport to discover harmful economic policies, it is, according to Stigler (1982b:16), the economists themselves who

are mistaken. Lack of success on the part of economists in using economic analysis to combat rent-seeking presumably stems from the fact that there are inexplicit goals that are not taken into account in economic analyses of these programs (Stigler, 1982a:10).

Consider the U.S. sugar price support program. The Stiglerian efficient view of the political process suggests that this program takes into account all relevant knowledge, including information that economists might know and provide. The sugar program presumably is efficient not just in the sense that the deadweight loss of transferring income to sugar interests is minimized--the income redistribution itself is Panglossian. Consequently, when economists find that the sugar program is inefficient, the correct interpretation according to Stigler (1982b:15-16) is that economists "refused to listen to the society, not that society refused to listen to the economists. What the economists had to say that was relevant was heard and acted upon." If the sugar program is superior to all available alternatives, including no sugar program, what can economic education contribute to public policy as it affects the sugar industry? In short, the implication appears to be that economists have nothing to contribute to sugar policy or, more generally, to the public policy process.

The conclusion that public policies cannot be improved assumes extraordinary knowledge and foresight on the part of voters and government officials, elected and appointed. In doing

so, it discounts the importance of imperfections in the political process, as described above and emphasized in the Virginia brand of public choice theory. The Buchanan-Tullock analysis of rent seeking and other forms of government failure has starkly different implications as to the potential for economic education in public policy.

The efficiency result in CPE studies, and the resulting implication that economists have no useful role in public policy, is inconsistent with conventional welfare economics and public choice theory, as emphasized above. Indeed, it is inconsistent with many other University of Chicago case studies of economic regulation that, in the words of Mitchell (1989:287), have yielded a "...Chicago litany of public failure...."

The implication that economists have nothing useful to offer in public policy also is starkly different from Stigler's earlier assessment of the unrealized potential of economists in the public policy arena. Consider Stigler's concluding comments in his Presidential address to the American Economic Association in 1964:

> The revolution in our thinking has begun to reach public policy, and soon it will make irresistible demands upon us....Our expanding theoretical and empirical studies will inevitably and irresistibly enter into the subject of public policy, and we shall develop a body of knowledge essential to intelligent policy formulation (Stigler, 1965: 16-17).

It is difficult to see how one can reconcile this earlier Stigler position that economics is at the "threshold of its golden age"

with his later view, labeled here as CPE.

Economic Education and Public Policy

Despite the impressive scholarship contributing to the CPE efficient view of the political process, there is abundant evidence that economists can make a significant contribution to public policy. However, it is important to recognize both what can and what can't be done in the public policy arena. Let us first consider the potential contribution by economists under the explicit assumption that current public policies can be improved.

What Economists Can Do

In a democratic society, elected officials are affected by public opinion and actions of bureaucrats are influenced by elected officials. Therefore, assuming that economic policies are not Panglossian, improvements in economic knowledge have the potential to improve public policy. The contribution that economists actually make, of course, hinges both on the usefulness of the work done and on how effectively the results are communicated.[11]

What is the historical record? There appears to be ample historical evidence supporting the thesis that ideas have

[11]What are the implications for graduate student education? Gordon Tullock suggests that the average graduate student in economics who is busily engaged in mathematics is "...unfitting himself for having any great influence in our political process" (Tullock, 1991:114).

consequences and can be important in political reform, although the process may involve a significant time lag (Hayek, 1991:36). Milton and Rose Friedman cite the example of the dismantling of the mercantalist structure of government in England during the 1800s, including the repeal of the Corn Laws. This final triumph of Adam Smith occurred some seventy years after Smith's campaign against protectionism.

More recently, it is widely conceded that economists played a leading role in the economic deregulation of the 1970s and 1980s in the United States. Economists provided both the intellectual foundation and detailed studies of the effects of regulation of specific industries in this deregulation movement that notably affected transportation and banking.

Economic events generally are consistent with more than one theory and Stigler (1982a) shows that these deregulation events can be interpreted in a way that is consistent with CPE. It may be argued, for example, that the repeal of the Corn Laws resulted from a shift in political and economic power as England's agricultural classes declined and its manufacturing and commercial classes grew. In like manner, the recent deregulation movement that affected transportation and banking in the United States might be attributed to shifts in political power arising from technological innovations, rather than to economic education. The importance of other factors in effecting change, however, is not mutually exclusive with the power of ideas. Economic education can affect public policy even in the short

run, as individuals' perceptions of specific government programs may change quickly in response to new information.

It should be recognized, of course, that economic education can have perverse as well as beneficial effects. Keynesian macroeconomics in the United States appears to be a good example. The Keynesian doctrine suggests that the federal government should use the budget as a stabilization tool, balancing the budget over the business cycle rather than each year. However, the idea that the government can "fine tune" the economy in this way ignores political realities. Politicians eagerly accepted the "new economics" that budget deficits are not necessarily bad. Keynesian economics, at least in part, provided a rationale to support the penchant of politicians to enact legislation on a "spend now and pay later" basis. Elected officials prefer programs in which the benefits to constituents occur in the short run, and the bills come due in the long run--after the next election! We are now reaping the fruits of this breakdown of fiscal discipline in the United States--chronic budget deficits regardless of the stage of the business cycle--a result that was aided and abetted by Keynesian doctrines.

Constitutional economics suggests that in an unlimited democracy, education alone is unlikely to be sufficient to achieve fiscal responsibility (Buchanan, 1989; Hayek, 1979). Rent-seeking groups are well informed and fight determinedly to obtain and maintain their legislated privileges, which benefit them at the expense of the public at large. Moreover, there is a

prisoner's dilemma and a "you first" problem. Economic output would be higher, i.e., all sectors considered jointly would be better off, if some force other than immediate self interest induced all sectors to forego rent-seeking activity. Even if all groups recognize the desirability of limiting special interest legislation, however, each group has an incentive to agree to stop rent seeking only if other groups also agree to do so (Anderson and Hill, 1980). In practice, each group benefitting by a special dispensation from the government is likely to favor a reduction in rent seeking in general while fighting to retain its own special advantage. The prisoner's dilemma, the central model of constitutional political economy, shows that rent seeking is likely to be substituted for production and exchange in a majoritarian democracy unless rent seeking is restrained through constitutional rules (Wagner, 1987). This suggests that the core of the problem arises from the incentives that ordinary people confront within this political system and that a significant reduction in rent-seeking waste is likely to hinge on institutional or constitutional reform (Wagner and Gwartney, 1988). Constitutional political economy or "constitutional economics," a recent variant of public choice theory, emphasizes choice among constraints rather than choice within constraints, as in conventional economic analysis (Buchanan, 1991a:4-5). Economists in their capacity as political economists or social scientists have important roles to play in helping to achieve the consensus necessary to bring about such reforms. Further

consideration of specific institutional changes to help channel self-serving behavior of participants toward the common good, thereby reducing rent seeking is, however, beyond the purview of this paper.

What Economists Can't Do

It is also important to acknowledge the inherent limitations of economic analysis in public policy. For example, economists can't determine the optimal pattern of resource use on a local or national basis. This task clearly is impossible, given the information problems described above. Indeed, sixty years ago Lionel Robbins emphasized the problem of attempting to base public policy on measurements of welfare effects of tariffs, price supports, and so on (Robbins, 1952). This attempt to provide a basis for "just" action by measuring the relative utilities of different people suffers from what Hayek (1988) termed the "fatal conceit"--the idea that government planners can structure societal arrangements to optimize our well being. Any such measurements must involve interpersonal comparisons that, in Robbins' (1981:8) words, "to put it mildly, would be highly conjectural." There is no legitimate way to measure and compare the benefits afforded to or the harm endured by different groups of people, and findings based on such interpersonal comparisons, according to Hayek, lack "all scientific foundation" (Hayek, 1979:201-202). The implication is that all policy recommendations involve value judgments and science by itself can never prove

what ought to be done (Hayek, 1991:20). Indeed, it may well be that Coase (1988:15) is correct in his contention that economic analysis is incapable of handling many of the problems to which it purports to give answers.

Conclusions and Implications

Conventional welfare economics and public choice theory suggest that public policies can be improved and imply an important role for the economist in public policy. In sharp contrast, in CPE there is no slack in the political process because decision makers are considered to be perfect agents of interest groups. But if there is no scope for improvement, how and why does change occur in the political process (Mitchell, 1989)?

There are opportunities for improvement in public policy, and for economists to contribute to this process as long as the political process is not perfectly coordinated. It is argued here that there is slack in the political arena because of information and incentive problems that are endemic in collective choice. These problems permeate not only the electoral process but the enactment and administration of legislation as well, suggesting that there is ample scope for improvements in public policy.

Despite the limitations of economics in public policy analysis stressed by Coase, Hayek, and others, economists can

play an important role in public policy.[12] First, economic theory can help make decisions in the political process more understandable (Kirzner, 1976). The U.S. sugar program cited above in which benefits are highly concentrated on a small number of sugar interests and the costs are widely dispersed over the population is one example.

Second, economic theory is highly useful not only in tracing out the direct effects but also in determining the indirect and unintended consequences of public policies. And it is the indirect effects of price controls, wage controls, and other policies that frequently get overlooked in public policy discussions. Economic analyses of these programs can help to achieve the consensus necessary for the development and implementation of intelligent public policies.

Finally, economists can have a positive impact on public policy by providing information about the responsiveness of alternative institutional arrangements to the values and choices of individual citizens. That is, the economist qua policy maker can help to identify, explain, and attain an institutional framework that will effectively enable individuals to cooperate in pursuing their own diverse ends.

In short, there appears to be ample scope for us as

[12]Hayek (1991:42) warns of the dangers of specialization in economics. "While you may be a very useful member of society if you are a competent chemist or biologist, but know nothing else....if you know only economics and nothing else, you will be a bane to mankind, good, perhaps, for writing articles for other economists to read, but for nothing else."

economists to contribute to public policy. However, as emphasized by Buchanan and Coase, less attention should be given to choice within constraints and more to choice between constraints. And, regardless of the specific problem, the objective should be an institutional framework that provides maximum scope for individual choice. It is only through this approach that resources will be used most effectively and the interests of consumers, producers, and taxpayers will best be served.

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SECTION B

PANEL PRESENTATION PAPERS

FISHING FOR PROPERTY RIGHTS:

PROPERTY RIGHTS MODELS AND ISSUES FOR NEW ZEALAND FISHERIES POLICY

A paper presented to the

NEW ZEALAND ASSOCIATION OF ECONOMISTS

and

AUSTRALIAN AGRICULTURAL ECONOMICS SOCIETY

JOINT ANNUAL CONFERENCE 1992

UNIVERSITY OF WAIKATO

Dr Brent Wheeler
Director
Wheeler Campbell Ltd
Wellington

24-26 August 1992

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JAS:UOW-FFPR

INTRODUCTION

This paper has three aims. The first is to explain the model of property rights developed to underpin the review of fisheries legislation recently carried out by the Fisheries Task Force in New Zealand. That model extends the traditional property rights framework employed by economists to describe a wide range of behaviours and to advocate particular policy stances for Government. The model has important theoretical and practical implications for understanding behaviour and policy in respect of resources, for example environmental resources, which at present lie primarily in the public domain.

A second more modest aim, which is anecdotal in nature, is to describe the application of that model to issues which are currently of concern in New Zealand fisheries management policy. It was within this context that the model was developed.

Finally, I seek to explain a generic model of property rights applied in this instance to New Zealand fisheries, but with wider application. That model draws on object-oriented programming concepts currently being developed and applied in data processing software design. The model provides a means for incorporating an expanded property rights model into a framework which can be given legislative expression consistent with the promotion of economic efficiency.

BUILDING ON PROPERTY RIGHTS MODELS

Setting aside the constraints imposed by the legislative legacy of past fisheries acts, a case exists to prefer the property rights model of economic behaviour rather than competing frameworks. Other models, notably the family of costly information models (Stigler 1962)[1], principal - agent models (Jensen and Meckling 1976)[2], and contracting models (Williamson 1975)[3], present certain difficulties. Some of the models, for example agent principle models, provide insights which are valuable, but extremely specific. Other models, for example costly information models, tend to be over-identified.

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1 Stigler G J, "Information in the Labour Market", Journal of Political Economy, Supplement 70 pp94.
2 M C Jensen and W H Meckling "Theory of the Firm: Managerial Behaviour, Agency Costs and Ownership Structure", Journal of Financial Economics 3, No.3, pp305.
3 O Williamson, "The Economic Institutions of Capitalism", New York, Free Press 1985.

These frameworks are more accurately described as a series of themes than as coherent comprehensive structures. The property rights model is more complete, especially when certain limiting assumptions are relaxed, and its principles placed in a comparative institutional framework.

The traditional property rights model tends to be static, to abstract from the real world, and to treat transaction costs inadequately. A more adequate specification of the property rights model needs to treat rights as dynamic, to conceive of rights as flowing primarily from a set of economic processes, and to treat the costs of transacting as being central to the model.

This essentially theoretical work was undertaken by me along with Tom McClurg and Roger Falloon of the Ministry of Agriculture and Fisheries (Policy Unit) as a precursor to the review of fisheries legislation undertaken by the Task Force.

In attempting to refine the traditional property rights model we drew heavily on the work of Barzel (1989)[4] as well as early work by Alchian (1965)[5], and Demsetz (1967)[6]. The concepts and their application were subsequently debated at length by members of the Task Force, as well as being subject, albeit in less theoretical form, to scrutiny from a wider public.

PROBLEMS WITH TRADITIONAL PROPERTY RIGHTS MODELS

As part of several current policy debates, economists have advocated the creation, normally by governments, of private property rights in a wide variety of resources. The development of environmental policy for example, has frequently seen economists advancing the view that private property rights in resources ranging from marine mammals to fresh water assets, should be created so that the benefits of private ownership can promote objectives which currently flow from societal preferences.

My contention is that the traditional property rights model is too crude to be applied in a simplistic fashion, and that its application in policy development has a tendency to paint options as polar extremes which appear incompatible and difficult to implement.

4 Y Barzel, "Economic Analysis of Property Rights", Cambridge University Press, Cambridge 1989.
5 A Alchian "Some Economics of Property Rights", reprinted in "Economic Forces at Work", Liberty Press 1977.
6 H Demsetz, "Toward a Theory of Property Rights", American Economic Review, 57, No.2 pp347-359.

Four limitations of the traditional property rights model may be identified as contributing to this difficulty.

1. All or Nothing Fallacies

Under traditional property rights models, rights are normally considered as being either public or private. There is a tendency to treat property rights as if they lay exclusively in the public or private domain.

As well as being a too rigid and inflexible means for characterising rights, this conception grates with empirical observation. The rights enjoyed by private property owners for example, are not exclusively in the private domain. Certain elements of almost every commodity, even where held under private ownership, remain in the public domain.

With individual transferrable quotas held by commercial fishers for example, the right to harvest is not complete. Instead rights to harvest by certain methods in certain areas and at different times of the year remain in the public domain.

The concept that ownership is either present or absent is therefore inadequate, and a more sophisticated framework in which the possibility of an intermediate state with imperfectly defined ownership rights must be admitted to the traditional property rights model.

2. Private Property Rights are Never Perfectly Delineated

A related limitation of traditional models is the failure to recognise that because transacting is costly, in economic terms property rights are never fully delineated. The costs of forming, measuring, and policing mean that imperfect delineation of rights may be optimal in a number of circumstances.

To make this point, Barzel cites slave societies where slave ownership itself was never absolute despite the slave's lack of legal protection. Owners were able to enhance the value of their property through granting slaves some ownership rights in exchange for services the owners valued even more. Notwithstanding legal ownership, owners had to spend resources to induce slaves to produce.

Consequently an imperfect delineation of property rights increased net benefits to owners.

In delineating fisheries rights or environmental rights, there may be net benefits to owners granting partial rights to interest groups such that perfect delineation does not exist. For rights to be perfectly delineated, information must be costless to obtain, and the costs of transacting must be zero. These conditions rarely, if ever, prevail, and imperfect delineation therefore becomes optimal.

A more complete property rights model must therefore contemplate imperfect delineation of property rights, and in doing so, move the costs of transacting to a central position in the property rights framework.

3. *Property Rights are Dynamic*

It is probably trite to observe that, as an economic matter, property rights and their value alter over time. Leaving aside legal considerations, changing values for commodities gives rise to alterations in the value of rights attaching to those commodities.

Pressure to give legal recognition to rights associated with recreational fishing, elements of the marine environment, and resources of interest to Maori, reflect alterations in the relative value of marine resources. Generalising, as the value of commodities increases, the value attaching to rights held in the private domain rises relative to the value of rights of a more public nature.

At some point the costs of transacting which attach to the delineation of private rights are exceeded by the value foregone if resources remain primarily in the public domain. As a consequence it is "worthwhile" to delineate rights of private or near private ownership more clearly. Examples of this process include the enclosure of the commons, the formation of rights in respect of North Sea oil, the evolution of ranchholders' rights in the American West, and the development of the Quota Management System for fisheries in New Zealand.

Importantly, a relative increase in the value of rights may also arise where the cost of transacting is reduced through technological innovation. Examples include the development of barbed wire in the American West which drove down the cost of delineating private property rights more adequately, and the development of data processing technologies for the management of fisheries, which drove down the costs of delineating individual transferrable property rights in the harvesting of certain fish species.

4. *Legal Delineation May Be of Little Consequence*

The traditional property rights model tends to align the existence of ownership and private property rights with consistent legal recognition originating from a government. Early work by Alchian and Demsetz (op cit) describes the development of private property rights without intervention from government. The development, implementation, and acceptance of the Quota Management System for commercial fishing in New Zealand owes at least as much to private economic interest as to public legal reform.

An important implication of this is that legal activism may be a poor means for generating equilibrium rights which promote efficiency.

The model of property rights used to drive the reform of the fisheries legislation sought to recognise and move beyond these limitations. Property rights were viewed as being neither exclusively in the public or the private domain, but as having public and private domain elements according to their relative value to owners along with the costs of forming, measuring, and policing private rights. Similarly, the level of delineation of property rights was assumed to be a function of the relative cost of transacting rather than a simple function of legal form.

Finally the model and the policy driven from it sought to recognise changing transaction costs and commodity values as a central part of the model. Consequently, the creation, maintenance, and exchange of property rights is an ongoing process rather than a set piece.

Assessment of issues for New Zealand fisheries management involves an application of these principles to issues of concern arising for those with interests in differing elements of the marine environment and its resources.

COMMERCIAL FISHING

The last two decades have seen the management of New Zealand fisheries resources move from an essentially unregulated open access policy through a variety of orthodox input regulatory regimes which sought to control exploitation of the resource to a system of

property rights management in which rights to harvest are placed in the private domain, and individual transferrable quotas are held by private commercial fishers.

This evolution may be described as a "classic" evolution in policy in which government has moved from a central "hands on" allocative management role to one of establishing and maintaining a private property rights framework within which commercial actors seek to create commercial value from fisheries, but in which government bears no responsibility for ensuring that such value is created.

That evolutionary process has been by no means smooth, nor, as noted above, has it been the exclusive preserve of government to generate the present framework. While numerous issues are presently of concern to commercial fishers, three concerns are worth focussing on in the current context.

1. The Quality of Fisheries Rights

A fundamental presumption of the Quota Management System is that if commercial fishers hold private property rights in harvesting of fisheries resources, then they will act in a manner which maximises the total value to be extracted from the resource over the long term.

This implies a quality of property right in which the nature of the right is near perfectly delineated and subject to change in a predictable rather than arbitrary or ad hoc fashion, and in which the duration of the right is more secure than under alternative regimes.

Where insecurity of rights exists, incentives for short term exploitation are present, incentives to over-capitalise relative to long term efficiency goals exist, and the benefits to be had from granting other interests, for example environmental interests, forms of ownership right are lower than would otherwise be the case.

In addition, the costs of appropriating benefits from collective action such as rebuilding stocks, contracting with other users of the marine environment, or refining corporate government structures, become prohibitively high relative to simple short term exploitation of the resource.

Attempts to improve the quality of private property rights in harvesting through the creation of static statutory rules based on coercion are unlikely to be successful.

Limited resources mean that enforcement is imperfect, and changing market conditions alter the value of rights continually.

Certainty of content is therefore likely to be less desirable and practicable than certainty of process. To some extent this can be achieved through administrative alterations such as the registration of title. Removal of regulatory blocks to trading of quota such as aggregation limits is also likely to improve the efficiency with which property rights and harvesting are used. More comprehensive coverage of species by the Quota Management System also has the potential to improve static allocative efficiency subject to the proviso that the rights formation, maintenance, and administration costs of more comprehensive coverage are likely to exceed the value of the harvesting right for species with limited markets.

Consistent with the model described above, all or nothing delineation of property rights and harvesting is therefore unlikely to be desirable.

Optimal policy may need to contemplate incomplete coverage by the Quota Management System, and predictable but continual alterations in the nature of the rights at the margin. These requirements raise issues about the processes for making fisheries management decisions.

2. Rightholders and Management Decisions

At present arguably the most valuable attribute of the harvesting property right, the setting of the total allowable commercial catch (TACC), is held by government. Significant incentives therefore exist for rent seeking behaviour, uncertainty as to the likely future value of the property right is exacerbated, and the value of rights lying in the public domain or associated with other users, is shrouded with uncertainty as well.

Moving the right to set the TACC from the public domain where it is currently exercised by government, to the private domain where it could be exercised by commercial fishers as rightholders, has the potential to enhance efficient use of the resource. That potential arises because of the improved alignment of incentives and greater predictability of process which could arise if the risks and costs of decision-making were to lie more squarely with rightholders seeking to create commercial value from fisheries.

The principal objection to such a move is that a significant number of other rights presently lie in the public domain, and the rights of other users remain imperfectly delineated at best.

3. *Improving the Property Rights Formation Process*

At present the creation of individual transferrable quotas in particular species is cumbersome in the extreme. Moreover, the chosen method of dealing with the problem of incumbency, through the allocation of rights on the basis of historical catch, tends to create perverse incentives.

Specifically, incentives exist to "fish for quota", and commercial fishers face few incentives to have regard for the rights of other users, potential users, and claimants on fisheries resources or the marine environment.

To the extent that government is involved in the formation of rights, processes which improve predictability and reduce uncertainty are likely to promote efficiency. Important improvements in this area would include reducing the government's role in allocating the resource available to quota holders, and abandoning the historical catch criterion.

RECREATIONAL FISHING

To date, interests in recreational fishing have been assigned almost exclusively to the public domain. There is no formal identification of rights with particular individuals, the level of exclusivity associated with recreational rights in the public domain is limited (see below), and government involvement with recreational rights has been restricted to regulatory regimes which manage inputs on the basis of a broad but ill-defined public interest.

This is not to say that ownership is completely absent. Section 28(d) of the present Act grants certain rights to recreational fishing activity in the sense that it requires the TACC to be determined by the Minister, having regard to the interests of recreational fishers.

The precise meaning and value of this right is unclear, but the introduction of the Quota Management System along with spatial depletion of species has generated an increase in value, evidenced through increased activism amongst recreational fishers, for the right.

The high costs of collective action amongst recreational fishers, the heterogeneous nature of the "income" sought by recreational fishers in exploiting the resource, and the discontinuous nature of recreational fishing, all combine to make a simple transfer of recreational fishing rights from the public to the private domain prohibitively costly at present. These characteristics may also mean that the artificial creation of comprehensive quasi private property rights in recreational fishing may not be efficiency-enhancing by comparison with other approaches.

A number of the Task Force's recommendations for improving the benefits for recreational fishers provoked strong negative reactions. This should not be surprising given the concentrated benefits accruing to recreational fishers, and the dispersed nature of the costs imposed by the activity, along with strongly held views about the impact of the creation of private property rights in commercial harvesting. Moreover, the widely held perception that the right to recreational fishing is a "birth right" along with the political nature of the allocation mechanism, mean that at least before the fact, incumbent recreational fishers saw little benefit in delineating their rights more clearly.

At the same time there is a wide spread recognition of the increasing ability to exclude which is being assigned to commercial quota holders, Maori rightholders, and environmental interests. The nature of existing recreational fishers' rights provides few avenues for transacting with these other interests. Neither does it confer any absolute right to exclude.

To the extent that recreational fishing activity is seen as beneficial, efficient allocation of the marine resource is likely to be enhanced by moving certain elements of the property rights closer to the private domain than they currently are.

Given the high costs of maintaining property rights in recreational fisheries, the relatively modest objectives of making explicit the recreational share of the resource, involving recreational fisheries representatives in resource allocation decisions, and providing for recreational fisheries groups to hold quota, seem likely to enhance efficiency.

A more nearly private right which the Task Force recommended was the creation of tradeable rules which confer the right of spatial exclusion of certain fishing practices to recreational fishers. In practice these would take the form of non-commercial fishing areas around the coast, the boundaries of which would be tradeable as would the nature and extent of the exclusions involved.

Issues concerned with the delineation of rights to recreational fishing, replete as they are with high transaction costs and collective interest characteristics, provide clear warnings against the simplistic application of static, all or nothing property rights models.

TREATY ISSUES AND MAORI RIGHTS

Objective discussion of the most appropriate means for dealing with Maori property rights and fishing resources is frequently obscured by emotive and melodramatic treatment of certain of the equity issues involved. A powerful characteristic of property rights models in general, and the particular model developed above, is the ability to abstract from this less productive debate. Instead it is possible to focus on the nature of the rights implied by government's obligations to Maori and the most efficient means for securing rights which are of relevance to Maori.

A first point is that the property rights involved are not all of the same type, nor do they all involve the same level of transaction costs. Consequently, once and for all solutions which seek to assign static rights as a consequence of the Treaty of Waitangi or legal argument over rights conferred through statute are unlikely to be optimal.

The Task Force distinguished differing interests which Maori have in the marine environment and its resources, and accordingly, advocated different forms of property right to deal with those interests.

Rights guaranteed under the Treaty of Waitangi may be characterised as having essentially private property right characteristics in that the Treaty confers a high degree of exclusivity, significant protection from attenuations, and binding obligations on the government in terms of maintenance and enforcement of the rights.

A further class of property rights concerns Wahi Tapu. A Wahi Tapu is a sacred place. Such places tend to be small in area and are clearly defined. Property right interests in Wahi Tapu involve exercising control over these areas to prevent food gathering and limit access, in accordance with customary practice of Maori.

These property rights are closely aligned to private ownership interests which are held by a group, in this case Maori.

Another class of property rights with similar characteristics though exercised with completely different purpose, are Mahinga Kaimoana. These refer to relatively small areas

of sea (estuary, reef, or coast line), where an Iwi or Hapu has maintained a strong tradition of food gathering together with the observance of conservation practices. Mahinga Kaimoana differ from Wahi Tapu in that Maori as a group have an interest in trading such rights amongst local Iwi.

A final class of rights is the Taiapure which is a coastal fishing area limited to littoral or estuarine waters established because of its special value to local Iwi either for fishing or spiritual reasons. This form of property right is closer to the public domain, being managed by a local committee from the local community. At present Taiapure resemble the regulatory regime based around central management strongly reminiscent of the detailed land use planning regimes of the Town and Country Planning Act 1977.

Finally, traditional take rights which seek to confer the right to gather Kaimoana for ceremonial or subsistence use also exist. While such rights lie normally in the public domain, they are subject to discretionary regulation on a private basis by elders of the Iwi.

Maori interests and property rights therefore range from those lying almost fully in the public domain through to rights which are delineated as near perfectly private. In addition, Maori have an interest in both public and private domain property rights in commercial, recreational, and environmental resources. Along with this wide range of rights is an attendant array of differing transaction costs which suggest that efficiency will be promoted by differing institutional arrangements and delineations of right.

The thrust of the Task Force's recommendations was that given a broad policy objective of recognising and securing Maori rights of all types, then a significant number of the rights, including decisions on whether or not to trade, need to be moved toward the private domain of Maori.

In practical terms this means that the relatively small areas making up Mahinga Kaimoana should carry rights of exclusivity and tradeability, that Wahi Tapu, the sacred place rights, should be afforded the same rights as land Wahi Tapu through existing Maori Affairs legislation, and that rights to the management of Taiapure should form part of the rights bundle held by Maori.

ENVIRONMENTAL INTERESTS

A significant and growing body of opinion has led in recent times to the value of environmental interests in the marine resource apparently being driven up. The value of

rights to establishing and maintaining certain largely undefined marine environmental standards appears to be such that the regulatory regimes associated with these rights which lie primarily in the public domain are inadequate as a means of reflecting the value placed on the marine environment.

In particular, the present arrangement of rights is not perceived as dividing the responsibilities for environmental standards adequately as between private rightholders such as commercial fishers, users with a stake in public domain rights such as recreational fishers, and users with a wide range of rights such as Maori, and broader environmental interests.

Problems abound in ascertaining appropriate rights regimes to deal with environmental issues. In terms of the model developed above, two particular characteristics are worth stressing.

First, the commodities to which rights are to be assigned are complex and ill-defined. Some environmental interests advocate the protection of intrinsic values for example. It is unclear precisely what such values are. A further concern is the protection of existence values. Delineating rights which could be attached to these commodities is likely to prove costly. Such costs are likely to be high whether the means of attaching rights to the property interests are regulatory instruments available to government, or ownership instruments associated with private property.

A second difficulty is that identification and measurement of the commodities and the rights, for example those embedded in standards whether public or private, is likely to prove very costly.

The mere presence of high costs does not, in and of itself, suggest that the benefit of assigning rights will be entirely cancelled out by the costs of transacting. The dispersed nature of the benefits may mean that incentives to create rights more akin to private property rights in certain environmental elements are, at present, relatively low. It may also suggest that the use of apparently simple low cost regulatory mechanisms by governments will tend to disperse costs and distort decision-making in ways which would otherwise not be the case.

The Task Force's response to these issues was to recommend developing a process of contracting amongst parties with an interest in environmental values in a more nearly private than public domain. It was argued that better incentives exist at a disaggregate level

in a contracting process which has the capacity to deal on a case by case basis with environmental issues than exist where centrally-based mechanisms are employed.

TOWARDS A GENERIC PROPERTY RIGHTS MODEL

In examining commercial, recreational, Maori, and environmental interests in fisheries resources it is clear that a wide range of transaction costs exist, and that differing degrees of property right delineation are likely to be appropriate. In developing a model to underpin future legislation, it therefore seems to be desirable to develop a generic model which provides flexibility, combined with predictability of change insofar as the property right framework itself is concerned.

The development of object-oriented programming in software design lends itself admirably to this task. The approach stresses generic objects, the notion of lesser objects inheriting characteristics of the "parent", and the concept of generic "process" sequences operating on objects.

The generic model developed has the following components.

Basic Fisheries Right

A basic fisheries right was defined as comprising the following attributes or settings which were defined as common to all rights:

- an area;
- a stock or species;
- an applicable compliance regime;
- exclusions of other parties; and
- duration.

The exclusion attribute would indicate the degree to which other rightholders are excluded. Marine farming rights generally exclude all other harvesters for example. An

individual transferrable quota however, does not exclude Maori or recreationalists from fishing the same species in the same areas.

The compliance regime refers to this system under which use of the right would be monitored to as to ensure its attributes were not violated. An individual transferrable quota would fall within the Quota Management System for example, while a marine farm might have to meet only a minimal compliance regime.

Processes

For the basic right, the following processes would or could be applied:

- creation;
- allocation;
- registration;
- combination;
- subdivision;
- exchange;
- transfer; and
- extinction.

Such processes could be initiated both by rightholders and by government. In particular government could be involved in the initial creation and allocation of rights. Other processes, for example registration, combination, subdivision, and exchange, could be purely private functions.

A further function of government could be provision of a structure similar to the companies legislation in which rules were provided for groups who wished to hold rights. Such rules might regulate the holding and exercise of property rights by group members and their relationship with other groups.

Each right would "inherit" all the basic attributes and processes of the basic right, but might have additional attributes to deal with over or under-use of the right, the carrying forward of unconsumed elements of the right in time, and the trading of rules so as to alter their impact.

A final advantage is that legislation can be drafted so as to mimic object-oriented approaches thus driving the economics and the law of the model together.

CONCLUSION

This paper has discussed, largely from a theoretical perspective, how an enhanced model of property rights can be applied to deal with the management of resources such as fisheries. The model developed has a number of wider applications which have the potential to break the somewhat sterile debate between public and private ownership which so often characterises discussions of appropriate reform which seeks to deal with issues such as environmental concern.

The primary modification to traditional property rights models which is required is a move from a static framework to one which is dynamic, recognises the cost constraints implied by imperfect worlds, and which employs a comparative approach to assessment.

The increasing value of interests in the marine environment, and the consequent demand for comprehensive means of dealing with the appropriate property rights to these resources, suggests that this area will continue at least in New Zealand, to lead in the field of establishing appropriate property rights regimes for resource use.

PROFITABLE LYCHEES - A SOUND REASON FOR INCREASING MILK PRODUCTION?

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HAMILTON, NEW ZEALAND
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I've been asked to speak to you today about some of the conclusions emerging from work I've been doing on agricultural marketing regulations in New Zealand. Given my audience it's unnecessary to spend time setting the scene in any detail. You'll know that New Zealand's agricultural marketing arrangements feature extensive regulation and restrictions on choice, and the debate over their pros and cons is long standing, continuing and at times quite doctrinaire. Unlike those relating to most other areas of the economy, this particular regulatory debate is yet to be resolved.

Intervention versus competitive markets - that's what the debate's all about. But then, when it comes to issues of regulation and public policy, isn't that what the debate's always about? What's intriguing to an outsider is how agricultural marketing has held out against the comprehensive and increasingly widely supported deregulatory changes in the New Zealand economy - including in agriculture's production sector. That topic, with particular emphasis on its political economy, would be a substantial conference paper on its own.

The main focus of the debate seems to be marketing methods. How can New Zealand make sure it doesn't get taken to the cleaners when exporting into a harsh, distorted and unfair international market place? While there are significant differences of approach between the major rural industries, they all have in common a philosophical thread which says producers must cooperate to survive. In some of the major industries this extends to regulations which make sure they do cooperate. The regulations ensure it's cooperate or don't participate - such is the restriction on choice.

Regulations and structures which coordinate and discipline market players are argued by some to be essential if New Zealand farmers are not to become peasants. Others, far from convinced that this fear would become reality in the absence of regulation, are concerned that restrictions and monopolies suppress ideas, innovation and capitalising on opportunities, and that there are inadequate means of accountability and sanction when it comes to measuring performance and responding to it. I'll return to some of these points - albeit briefly - later. What I want to do now is talk about lychees.

This brings me to the only diagram I intend to use today. This diagram, I'm sorry to say, has no asymptotic curves, no tangential straight lines, no undesirable rectangles or triangles, and no axes marked price or quantity. It does, however illustrate some important economic principles.

The diagram is the label from a can of lychees I recently had the pleasure of consuming. The lychees, according to the label, are the produce of Thailand. They were purchased from a supermarket in the New South Wales country town of Yass - better known for its super fine wool than lychees. Most importantly, given my subject today, the label tells us the lychees were marketed in Australia by a company called Riviana.

Riviana is an Australian-based company wholly owned by the New Zealand Dairy Board. Being of charitable nature I assume Riviana is a profitable enterprise. I'm sure New Zealand dairy farmers would only be interested in owning an investment which was profitable. I'm less sure, however, they're aware their board markets lychees.

So, the question I want to focus on is: Where do Riviana's profits go? It's my contention that this apparently mundane question goes to the heart of one of the major faults of agricultural marketing arrangements in New Zealand.

To answer my own question: Riviana profits are distributed to New Zealand dairy farmers. However, they are distributed as part of the price these dairy farmers receive for their milk. It's the only way they can be distributed. Hence, by logic which is elegant if only because of its simplicity, the profit from my can of lychees, the product of Thailand and marketed in Australia, encouraged a marginal increase in New Zealand milk production.

This is an economic cause and effect relationship one would expect to find behind Alice's looking glass. How did it move from there to reality? To answer that question you need to go back to the origins of current regulations, and the producer philosophy and objectives underlying them.

Most of the existing regulations originated or underwent major modifications during periods of low producer prices. Producers, who are a long way from the markets and busy doing what they're best at which is production, wanted explanations and solutions to what they considered unsatisfactory farm gate returns.

Two major reasons for poor returns were invariably identified. The first was that processors and marketers were believed to be under-exploiting market opportunities and lowering returns by unnecessarily competing

with each other. The second and somewhat contradictory reason was the belief that businesses beyond the farm gate were making profits at producers' expense.

Given the producers' objective of wanting to improve farm gate prices, the solution they grabbed was as logical to them as it was satisfying to implement. If they could take over operations beyond the farm, and ensure everyone behaved in a coordinated and disciplined fashion, then by definition, it would seem, production would be marketed in their best interests.

This is how producers set off down the path of largely involuntary off-farm investment in processing and marketing. While the extent of this investment and associated regulations vary between industries, producers in most industries have been required to make some off-farm investment in marketing.

It's akin to vertically integrating the farm with all or some aspects of processing and marketing. While there is nothing wrong with vertical integration in a competitive market, in New Zealand agriculture it produced a plethora of boards, commercial subsidiaries, and cooperatives - the structures producers chose to pursue their objective of better farm gate prices.

The consequences of choosing better farm gate prices as the primary objective, and having the marketing structures it led to, are quite profound, and shed light on many features of the so-called marketing debate. Probably the most important consequences arise because farm gate prices are a bundle of returns from different investments.

The farm gate price is a commercial cocktail which can contain returns from the producers' output sold in a variety of markets paying different prices, returns from trading the same products produced in other countries and products unrelated to the industry, and returns from privileged market access where it exists. Put in simplified terms, the farm gate price bundles returns from the farm investment with returns from other investments but in a manner which has the producer thinking it is a return to farm production only.

A situation exists in all major industries whereby the individual farmer compares marginal cost to produce with a return at the farm gate which invariably exceeds the marginal revenue received in the market place for the output. The only variation between industries is the size of this difference and hence the extent - assuming similar supply elasticities - of the production and valuation distortions it creates.

Much is said in the marketing debate about the ability of coordinated and disciplined marketing to improve market returns and farm gate prices. The underlying economics is that of the discriminating monopolist. It can be readily demonstrated, and many researchers have, that if demand characteristics differ between markets and certain market separation conditions are met, then a single or coordinated seller can deliver gross revenue higher than would be achieved from competitive marketing.

The potential of international markets to allow this form of behaviour is a contentious matter. Certainly, in the longer term, the benefits of the discriminating monopolist are eroded by competition from other suppliers and substitutes. It's extremely difficult to hide success and prevent others from attempting to get a slice of the action. The limited empirical research relating to New Zealand that I have seen confirms this conclusion.

However, if it is assumed that market characteristics will allow the discriminating monopolist some success, then this success will only be maximised by the monopolist controlling the supply coming forward for sale. A bundled farm gate price prevents this from happening. The commercial cocktail received by the producer invariably leads to more output than the discriminating monopolist needs. The discriminating monopoly benefits are dissipated because the marketer cannot control production.

This problem, arising from the bundled return, does not disappear if, as I believe, the ability to be a discriminating monopolist is very limited or non-existent. This is because the farm gate price, even in circumstances where the New Zealand marketers do no better than anyone else, contains the return to off-farm investments in processing and marketing. Producers receive more for their marginal production that it is actually sold for. They over-produce relative to what the market will buy at the prices they are receiving.

If a farmer had shares, say in the retailing sector, it's implausible that the return from that investment would lead to increased farm production. The farmer's decision - commonly enforced by regulations - to invest off-farm in processing and marketing is analogous. Farming, processing and marketing are separate investments. The level of farmer investment in each should be determined by their respective profitability. Furthermore, many farmers may only want to invest in farming.

The problem occurs in all the major rural industries. Lamb production should not necessarily increase because Meat Board investment in Japan, or in pet food in Australia, is profitable. If the Wool Board's new marketing company is profitable then its owners, that is woolgrowers, should receive a dividend which would not be a reason for increasing wool production.

Obtaining a windfall profit in the UK butter market because New Zealand has a quota is definitely not a reason to increase milk production. The same applies in the case of profits from marketing lychees.

The bundling of returns from farm and off-farm investments means existing regulations and structures distort resource use and incur economic costs, regardless of whether or not they are effective in raising market returns for producers' output. If they are successful in this latter role, the distortions are simply greater with current arrangements.

I'll return shortly to what is an obvious and beneficial solution to this distortionary problem of the bundled return. However, I want to comment first on some other implications of the emphasis producers have placed on maximising farm gate prices.

The performance of those in the boards and cooperatives is judged on how well they maximise the bundled return. The emphasis in all industries is on changes in farm gate prices. Relatively little attention is paid to returns on investment or profitability of the separate investments.

This places the marketers on a hiding to nothing. Producers reward their commercial success by producing more regardless of the exact reasons for the farm gate price rising. The extra output has to be sold, usually requiring lower prices to achieve market clearance. This pushes the bundled return down and exposes the marketers to criticism for not achieving their

objective. The sale of butter to the former Soviet Union in 1990/91 at prices below the GATT minimum is an example of these consequences.

One might conclude from this logic that New Zealand's agricultural marketers are among the best in the world because the more successful they are at raising farm gate prices, the more output they have to get out and sell, even if the market doesn't want it. One wonders whether the tireless butter marketer appreciates the extent to which his workload is partly the consequence of the lychee salesman being so successful.

These unenviable circumstances explain much of the marketer behaviour and rhetoric so characteristic of the debate in New Zealand. For example, they explain why regulated marketers place so much emphasis on maximising quality; exhorting producers to raise quality and often using the regulations to make sure they do.

All markets exhibit quality/price relationships. While there are clearly price premiums for superior quality, there are also profitable markets for lower qualities if they are labelled and priced appropriately. However, under many current marketing arrangements there is a disincentive for the marketers to encourage or allow lower quality output to be marketed even if it can be sold profitably. It would lower the average farm gate price measure on which marketer performance is judged.

These incentives to keep raising minimum quality standards can be seen at work over recent seasons in the kiwifruit industry. In one season, minimum export standards were even raised during the year causing considerable consternation amongst growers, and leading to a regulatory change to prevent this happening other than at the beginning of a season.

It has occurred to me that in the circumstances I'm describing the easiest way for a regulated marketer to maximise farm gate prices, as reported, would be to export only one container of product of spectacularly high quality. I presume this extreme action is not taken because its absurdity would be apparent.

The producer focus on maximising farm gate prices also explains why the debate is so heavily concentrated on how well marketing functions are executed. Performance assessment and reporting revolves around indicators of marketing activity and practice, and measures of unit returns,

sales turnover and market shares. This tells us little about profitability. However, it's somewhat unfair to ask marketers to maximise farm gate prices within existing structures, and then criticise them for actions which prevent satisfactory measurement of investment returns, and demonstrably constrain profit maximisation in the national interest.

Let me now return to possible solutions to the economic distortions created by bundling.

One possibility would be to administratively constrain output - production controls of some type. I consider this a very unsatisfactory option for a host of reasons that have been well researched and demonstrated. I also think it would be unacceptable to most producers. However, before I move on it's worth noting that marketers have demonstrated some understanding of the need to restrict production under current regulatory structures.

The dairy industry flirted with a production control instrument in the mid-1980s. The apple industry's proposals for raising the second tier levy and introducing transferable crop certificates - eventually thrown out by the Privy Council - was an attempt to constrain production growth even though this was not its stated purpose.

Only last week I saw a media report about a dairy cooperative that has had a moratorium on new suppliers for some months and aims to alter its structure to ensure it raises more capital from those suppliers demanding increased processing facilities. Finally, I think that in some industries the control of minimum quality standards is used as a fairly blunt instrument for production control.

The alternative, and I think far more desirable approach to the bundled return problem, is simply to unbundle the return. Deliver to the farmer an output price which will call forth that quantity of production which can be processed and marketed profitably, and deliver the remaining part of the return separately, essentially as a dividend on off-farm investment in processing and marketing.

Taking the dairy industry as an example, let's assume that nothing else changed except that the board and the cooperatives were restructured into a more standard corporate form with the equity given to dairy farmers and only able to be traded amongst them. This structure would differ from

current marketing arrangements only insofar as it would require these organisations to work in the interests of dairy farmers in their capacity as investors in the organisations, rather than in their capacity as suppliers to the organisations.

The importance of this distinction was highlighted by AFFCO's Chief Executive when, in his 1991 Annual Report, he said that as a cooperative the "Company has consistently failed to separate the interests of its shareholders and suppliers. While the company has had to pay competitive prices for livestock, the need to produce commercial rates of return on shareholders' funds has not been given priority." He concluded that "as a consequence the Company's performance overall has been unsatisfactory."

Returning to the dairy example, the separate posting of output prices and other returns may mean that dairy farmers receive less for their milk the day after the change, but it will not be a distorting price anymore. They will, however, also receive a dividend and be able to exercise investor choice. The choice decision will be based on how they view the share price and the dividend - indicators of performance which are far more useful than those currently available.

The same types of changes could be made to boards or their business subsidiaries in other industries with the same beneficial consequences. In fact, it's hard to see any reasons why producers, cooperatives or the boards would not be keen to ensure this happens expeditiously.

The discussion so far has concentrated on the case for unbundling the farm gate price and I have not considered the issue of regulations constraining competition and choice. Such regulations are not costless. There is valid suspicion about the efficiency of organisations not exposed to competition and conventional market sanctions. There is reasonable concern that not all opportunities and ideas are being exploited. For conclusions in these areas one looks to logic and evidence from within the industries, in New Zealand and internationally, and from other parts of the economy.

I think when it comes to performance measurement one of the most striking consequences of agricultural marketing regulations and the structures they underpin is the absence of useful information on commercial performance, and the frequent lack of competitive performers against which comparisons can be made. As I have already noted, measures

of activity tell you nothing useful about commercial performance. A lack of investor choice severely blunts the effectiveness of any sanctions against poor performance - bearing in mind the deficiencies in performance measurement to start with.

A useful place to look for evidence that the introduction of competition delivers better performance are those areas of the New Zealand economy where this has occurred. One is port reform where farmers have seen and benefited from improved efficiency and significantly reduced costs. The same applies for financial and labour market reform. Improved productivity in the transport, energy and communications industries reflect the benefits of being exposed to incentives and sanctions of the type found in the competitive private sector. It needs to be recalled that in all these areas the prior message from supporters of the status quo and those in the monopoly organisations was that they were efficient businesses keeping costs to a minimum and maximising innovation. "If it ain't broke, why fix it?" was the refrain.

In my research I've come across and documented numerous cases where ideas were discouraged or suppressed, and investors showed reluctance, because of regulatory barriers or concerns about the regulations changing unexpectedly. There are also numerous instances were foreign investors simply by-pass New Zealand because they see agricultural regulations and monopolies blocking opportunities. Why should they bother when they can go to Australia, Argentina, Brazil or Chile, just to name a few.

It is frustrating and disappointing to see New Zealand's rural producers forgoing the opportunities which would flow from this investment, and the ideas, skills and market connections it would bring.

The suggestion of more competition in marketing invariably brings the response that competitive exporting from New Zealand will lower producer returns. Only where genuine market power opportunities exist will this be the case on any systematic and continuing basis. The UK butter quota is an example at the extreme. Competitive exporting to this market would erode and possibly lose completely the quota premium the British have made available to New Zealand, in part as compensation for lost markets. However, a single seller monopoly is not the only means to capture the premium and the existing regulations in New Zealand ensure most if not all of it is dissipated by supply response distortions anyway.

Beyond this particular example I've found it extremely difficult to find evidence of significant market power available to be exploited by a "New Zealand Incorporated" approach to marketing. In cases where the exports are of a commodity type there are invariably other suppliers and very limited bases for product differentiation. In cases where the product can be differentiated, particularly by value adding and branding, then so-called weak selling or competitive exporting would seem to be an irrelevant issue.

Then there are substitutes to consider. All New Zealand's agricultural exports have readily available, close substitutes. In today's competitive and price conscious markets it is extremely difficult to prevent consumers from switching products when price differences emerge. Finally, let us not forget all those investors who look at New Zealand but decide somewhere else is preferable. No one has yet explained to me how New Zealand's regulated marketers are going to stop these producers from "weak selling".

I have only been able to address the important issues of regulatory inefficiencies and market power superficially today. This partly reflects the emphasis I wanted to give to the bundled return and its consequences. I would like to conclude by issuing a couple of challenges in regard to the bundling issue.

I have argued that the simple and readily available solution to the bundling problem is to corporatise boards, their commercial subsidiaries and cooperatives, and place the shares in the hands of producers. If nothing else changed and only producers could trade the shares, arguments about the pros and cons of regulations which control and compel certain forms of marketer behaviour do not arise immediately.

My first challenge, therefore, is to producers and those responsible for their processing and marketing organisations. What possible arguments could there be against privatisation on the constrained basis I have suggested? Distortions would be removed and performance transparency would be improved.

There are two possible reasons why the corporatisation option may be unattractive to some. The first is that the benefits claimed for existing structures may owe more to rhetoric than substance. Maybe, dare I say it, they are actually negative. The second reason is that if the distortions are

significant, and I believe they are in a number of industries, then some painful asset revaluations are going to have to occur in the course of achieving the longer term benefits.

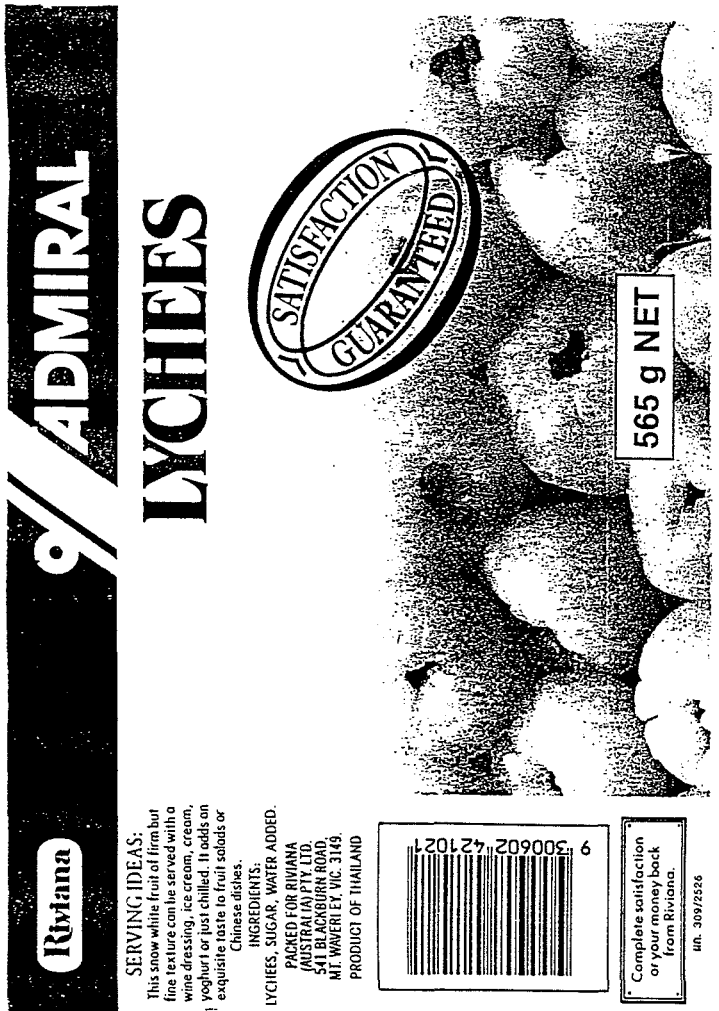
This latter point brings me to my second challenge and it is a challenge to New Zealand's economic researchers. Get out there and research, evaluate and publish your work on the size, significance and economic consequences to New Zealand of these distortions. The profession has a role in this important area of the economy similar to the one it played effectively in the tariff debate. As with tariffs, the distortions are hidden and not appreciated, particularly by those - in this case producers - who continue to believe they are beneficiaries.

I think the process could start with the simplest sort of calculus. Take the dairy industry which I have used as my main example today. New Zealand dairy farmers have approximately $2.5 billion invested off-farm in their cooperatives and the board. Presume these dairy farmers want a dividend on this investment similar to the average of New Zealand's corporate sector. In the case of dairy, add to this 'normal' investment return the premium from the UK butter quota. I have conservatively estimated this premium in recent seasons at around $125 million annually. These two figures - a normal return from the off-farm investment and the quota premium - are a reasonable approximation of what dairy farmers should expect to receive before they even contemplate returns to the dairy farm investment.

Now look at MAF estimates of dairy farmer profitability over recent seasons. Compare the aggregate net income in dairy farmers' pockets with what should be received from the off-farm investment alone. Then ask the important questions regarding what resources in milk production are actually returning, and how extensive resource misallocation might be. In other words, what are the current arrangements costing New Zealand?

As a profession, taking up this challenge will not be easy. There is a widespread view that the Dairy Board is a world class marketing organisation. The irony is that, at least on the basis of the issues I have focussed on today, I am not challenging the veracity of that claim. In fact, I am suggesting an option which, while removing distortions, would provide us with better, albeit imperfect, information on performance.

As with the tariff debate, and the debate over the labour market, there are many facts which need to be highlighted, and myths that need to be dispelled. Perhaps we could start with the myth that because lychees and cream are joint products in cuisine, they must also be joint products in the economic sense of that term.



SECTION C

CONTRIBUTED PAPERS

C-1 AGRICULTURAL ECONOMICS AND FARM MANAGEMENT

THE WORK AGENDA IN AGRICULTURAL ECONOMICS
What Should Agricultural Economists Do Differently?*

E. C. Pasour, Jr.**

> ... academic economics and graduate training have become increasingly preoccupied with formalism and technique, to the exclusion of studying real world problems and issues that can be illuminated with some blend of theoretical, empirical, and institutional research (Hansen, 1991:1054).

The above citation is from the report of the American Economic Association's recent Commission on Graduate Education in Economics. It reflects an increasing concern among economists in the United States generally, including agricultural economists, about the focus of economic analysis. Some agricultural economists, including Bonnen (1986), Johnson (1971), Schuh (1986), and McDowell (1988), have deplored the lack of relevance of agricultural economists in land-grant universities, notably the gap between the frontiers of knowledge (especially disciplinary research) and the problems of society. Other prominent members of the profession for more than a generation have decried agricultural economists' overemphasis on the use of mathematics and formal model building (Brandt, 1955; Paarlberg, 1963; Farrell, 1976; Hoch, 1984; Breimyer, 1991).

It is noteworthy that the AEA Commission found considerable agreement that the use of mathematics in economics is overemphasized (Hansen, 1991:1086). Many, if not most,

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agricultural economists are likely to agree with Friedman (1991:36) that although math has greatly extended the power of economic analysis, the computer revolution has induced economists to carry reliance on math and econometrics "beyond the point of vanishing returns." Indeed, Just and Rausser (1989:1190), following a recent survey of members of the American Agricultural Economics Association, concluded that the profession has become too technique oriented and make a plea for the publication in the American Journal of Agricultural Economics of more highly readable papers on problem definition and heuristic applications of economic principles.

The issue of tool-oriented research in agricultural economics is important, but it is not the primary focus of this paper. It is instead addressed to two closely related issues, only one of which has received significant attention from agricultural economists. The thesis of the paper is that additional emphasis on political economy and the operation of the entrepreneurial market process would improve the effectiveness of research and educational work by agricultural economists.[1]

My comments are organized around three topics. First, the conventional equilibrium approach of neoclassical economic theory is contrasted with the entrepreneurial market process approach. The contention is that additional emphasis on operation of the

[1]The paper focuses on agricultural economics work in the United States. However, the work agenda in agricultural economics in Australia and New Zealand appears to be quite similar to that in the United States.

market process would highlight problems of uncertainty and information, including transactions costs, that warrant more attention in economic analysis. Second, it is suggested that the marginal payoff is likely to be greater from an increased emphasis on the institutional framework--on issues of political economy--than from additional work in the conventional mode that heavily emphasizes choice within constraints. Third, implications of the proposed changes for the work agenda in agricultural economics are discussed.

Equilibrium vs. Entrepreneurial Market Process Approach

Although it is recognized generally that entrepreneurial activity is an inherent and highly important feature of the market economy, the entrepreneur seldom appears in the literature of conventional economics, including agricultural economics. In economic theory texts, for example, references to entrepreneurship are scanty, and quite often they are totally absent. In the words of Baumol (1968:69), "The theoretical firm is entrepreneurless--the Prince of Denmark has been expunged from the discussion of Hamlet."

Why have entrepreneurs not received their due in conventional economic analysis? Kirzner (1973) traces the neglect of entrepreneurship to the general preoccupation of neoclassical theory with final equilibrium positions. In competitive equilibrium the decisions of all market participants dovetail completely so that there are no profit opportunities

and, consequently, no role for entrepreneurship.

The conventional equilibrium approach abstracts from knowledge problems by merely assuming that information and transactions costs "are such as to provide the conditions that are required for equilibrium" (Schultz, 1975:829). In sharp contrast, information or knowledge was the focus of Nobel Laureate F.A. Hayek's classic article "The Use of Knowledge in Society" (Hayek, 1945). In this paper, which is rich with public policy implications, Hayek stresses that the marginal efficiency conditions of welfare economics are not the economic problem that society faces. The data on available resources, production opportunities, and consumer preferences that are necessary to use these optimality conditions for policy purposes cannot be obtained by policy makers. Thus, the economic problem that confronts people in any country is how to secure the best use of resources available to members of society for ends or purposes the importance of which can only be known by them (Hayek, 1945).

The Hayekian approach focuses on the market as a decentralized process in which market prices play a unique role in the discovery, coordination, and transmission of information to market participants throughout the production and marketing system. Much of the relevant information in achieving a productive economy is highly specialized to time and place and cannot be summarized in statistical form for use in central planning. Hence, as Hayek stresses, the entrepreneurial market process in which economic decisions are made by the "man on the

spot" cannot be simulated through central direction.

The implications of Hayek's work are now more widely recognized by the economics profession following the breakup of collectivism in Eastern Europe and the former Soviet Union. However, implications of the Hayekian insights for economic analysis and government regulation of economic activity have been largely ignored in agricultural economics--at least in the United States.[2] Let us now consider several examples involving information problems.

Opportunity Cost and Economic Efficiency

The subjective nature of opportunity cost poses an important but widely ignored information problem in the traditional equilibrium approach of neoclassical economics. The opportunity cost of any action is the value of the sacrificed alternative. Opportunity cost exists only in the mind of the decision maker, however, because the foregone alternative is not actually experienced (Buchanan, 1969b). The cost to Farmer Jones of going fishing on a given summer day, for example, is the expected payoff from plowing corn--if Jones considers plowing corn to be the best alternative use of his time. The expected cost of any activity for different individuals will vary, of course,

[2]Most agricultural economists did not study Hayek's work while in graduate school and work by this Nobel Laureate goes largely unnoticed in the American Journal of Agricultural Economics. During the period 1986-1990, for example, Hayek's work was cited a total of 804 times but was cited only twice in the AJAE (Social Sciences Citation Index, various issues).

depending upon their subjective assessments of the sacrificed alternatives. Thus, the opportunity cost of going fishing on any given day for Farmer Smith is likely to be quite different from that for Farmer Jones.

Consider the problem that arises in the situation depicted when an observing economist attempts to identify economic inefficiency. In the above example, Farmer Jones can increase time spent fishing only by reducing time spent in tending corn or in other uses. Therefore, the decision by Jones to fish rather than to tend corn results in a different output mix rather than a decrease in output (Stigler, 1976). The expected value of the time spent fishing presumably is valued more highly than the sacrificed alternative, the expected increase in corn production. Consequently, agricultural economists cannot legitimately conclude that Farmer Jones, who substitutes time fishing for a higher expected corn yield, is inefficient. Indeed, the very nature of opportunity cost means that the data upon which choices are based are distinct from data that can be objectively measured by an observing economist (Buchanan, 1987). The implications for economists' attempts to measure economic efficiency meaningfully, though manifest, have been largely ignored. Let us now turn to another area that has received short shrift in conventional analyses.

Transactions Costs and Market Failure

R.H. Coase won a Nobel Prize in 1991 for his pioneering work on property rights and transactions costs. Despite the significance of transactions costs in the analysis of "market failure" problems and the implications for institutional reform, this topic too has received relatively little attention in agricultural economics. Consider the example of a spillover in the form of soil erosion, which pollutes streams. The reason individuals and private organizations do not eliminate such spillovers is that the perceived gain would be more than offset by what would be lost in doing so. Of course, as Coase (1988:27) emphasizes, the transactions costs of making the arrangements necessary to bring about the result are properly included in the calculations of costs and benefits. And when such costs are included, economists have yet meaningfully to describe or define "market failure" in a way that has public policy implications.[3]

The fact that one cannot prove logically or empirically that there is market failure when a real world spillover is observed does not imply, of course, that the existing situation is Panglossian. Indeed, it is likely that there are superior institutional arrangements because the political process is not

[3]The problem of identifying market failures under real world conditions frequently is discounted in economic analysis, including agricultural economics. "In many countries market failures abound...Market failures emanate from a number of different sources: unclear and insecure property rights, significant externalities, imperfect competition, informational imperfections...and so on " (Rausser and Zusman, 1992:249). But if cost (including transactions costs) of eliminating a market failure were less than the benefit, presumably it already would have been done! How then is "market failure" meaningfully defined or identified?

perfectly coordinated. Moreover, explicit recognition of the importance of transactions and other information costs in economic analysis tends to shift the emphasis away from traditional optimization approaches that take the institutional framework as given and toward institutional reform. Increased recognition of transactions costs in public policy work also highlights the importance of considering choice between institutional constraints.

Choice Between Constraints versus Choice Within Constraints

In classical economics, the main purpose of political economy was to contrast alternative political and economic frameworks in order that choice among those institutional arrangements might be better informed (Buchanan, 1989:4). In contrast, methodology in agricultural economics today is strongly oriented toward an analysis that concentrates on choices made within constraints that are imposed exogenously on the person (or persons) making the choice rather than on choice between institutional arrangements (Buchanan, 1991; Hildreth, 1965:1503).

There are at least two reasons for placing more emphasis on choice between constraints. First, it is increasingly apparent that the appropriate role of government is an important policy problem in any society and that a proper institutional framework is a necessary condition for economic progress. Second, recognition of the fact that those structural constraints are subject to deliberate choice would help to ensure that economic

problems are defined more realistically and, at the same time, make it more likely that entrepreneurship and transactions costs are considered in economic analysis.[4]

In the choice of institutional arrangements, it is important to study the operation of the political process as well as the market process. Information and incentive problems are inherent in the political process but generally receive little attention in the evaluation of alternative institutional arrangements.

Information problems are endemic in the political process because of the separation of power and knowledge. Those with political power do not have and cannot obtain the information that is conveyed automatically through market prices (Hayek, 1945).

This information or knowledge problem was the central issue in the "economic calculation debate" between socialist theorists and Austrian economists, notably Ludwig von Mises and F.A. Hayek, that occurred in the period between the World Wars (Hayek 1948; Lange and Taylor, 1938; Mises, 1951). The calculation debate demonstrated that the structure of production cannot adapt efficiently to consumer wants in the absence of competitive markets and the information and incentives conveyed through market prices (Wagner, 1989).

Problems also are endemic in the political process because of incentive problems rooted in the separation of power and

[4]The conventional Robbinsian approach, which focuses on the allocation of scarce resources among competing ends, contributes to a tool-oriented maximization approach (Robbins, 1952).

responsibility. Incentive problems are a major concern of public choice theory. Whereas profits and losses provide the driving force for entrepreneurs in market decisions, there is no "bottom line" in the collective choice process where political decisions are substituted for the discipline of the market. Consequently, the political process frequently is biased toward the short run as individuals and groups engage in "rent seeking"; that is, attempts by them to increase their wealth through the aegis of the state. Rent seeking diverts resources from a socially productive pursuit, the production of goods and services, to a socially nonproductive activity, the scramble for government transfers (Buchanan, Tollison, Tullock, 1980). What are the implications of the problems just described as to what agricultural economists should do?

Implications for the Work Agenda in Agricultural Economics

At least some of the implications of the preceding discussion for research and educational activities in agricultural economics are quite clear. First, as Coase suggests, more attention would be given to the comparative institutions approach because economic policy always involves a choice among different social institutions. Therefore, improvements in public policy are unlikely to occur without knowledge of alternative political and economic arrangements under real world conditions in which information is costly and incentives frequently are perverse.

An increased emphasis on institutional and constitutional issues suggests an increased focus on public choice theory, the use of economic principles to explain decisions in the political process. The proposed change in focus would highlight government failure as the analog of market failure.

The recommended shift in emphasis also has implications for tool-oriented work. A comparative institutions approach is likely to be less amenable to quantitative approaches when compared with research and educational efforts with the institutional framework taken as given. However, Coase's opportunity cost assessment of formalism appears to be relevant for agricultural economics: "I do not mean to suggest that we should avoid quantitative work. But it is well to remember that there is no such thing as a free statistic" (Coase, 1974:181).

In the proposed comparative institutions approach, more attention to other disciplines, including political science, economic history, and philosophy would widen horizons in agricultural economics and permit a firmer grasp of what economics is and what it cannot be. For example, as agricultural economist Karl Brandt (1955) stressed almost forty years ago, economics cannot be the arbiter of values for society and it cannot determine what ought to be done.

Second, in addition to increased weight on institutional issues, more emphasis would be placed on information and uncertainty in the analysis of real world problems. It has been only during the past 10-15 years that the information problems

stressed by Hayek a half century ago have begun to be understood and appreciated in the economics profession (Stiglitz, 1991). And, as indicated by citation data, there still is little recognition of the importance of these insights in agricultural economics--at least in the United States. Increased awareness of the importance of information problems in the operation of the entrepreneurial market process would affect research and educational programs in economics, including agricultural economics.

The subjectivity of cost, largely ignored in agricultural economics, has important implications for economic regulation, including marginal cost pricing and the basing of agricultural price supports on cost of production (Pasour, 1990).[5] It is important to distinguish between the opportunity cost concept as a tool in economic analysis and the translation of marginal cost into an operational decision rule in economic regulation. Opportunity cost is a highly important tool in economic analysis, but economic regulators cannot simulate the competitive market process by setting price on the basis of marginal cost.

Subjectivism, and the associated information problems, also has important implications for economic theory, including the theory of the firm.[6] This suggests that more attention should

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[5]The implications of the subjectivity of cost in economic studies of environmental problems is emphasized in the "new resource economics" (Anderson, 1982; Fox, 1992).

[6]Hayek graphically describes the importance of subjectivism in the development of economic theory. "And it is probably no exaggeration to say that every important advance in economic theory

be given to "the economic way of thinking" or intuitive economic analysis at both the undergraduate and graduate levels. An emphasis on technique tends to depreciate the importance of entrepreneurial problems because no satisfactory way has been found to handle uncertainty and information problems in formal models.

Third, the relationship between the institutional organization of research and education and the work agenda in agricultural economics warrants more emphasis--at least in the United States. Agricultural economists in the United States are located in separate departments operating within the land grant university-U.S. Department of Agriculture system. This system serves to separate agricultural economists more, both from their basic discipline, economics, and from political science, history, and other subject matter that assists in placing economic problems in perspective (Castle, 1971; 1977).

Government support of academic activity even under the best of circumstances generally has unintended and undesirable consequences. Nobel Laureate and agricultural economist T.W. Schultz has observed that the more heavily a researcher is dependent on the patronage of government, the less the freedom of inquiry in the social sciences (1979:474). Indeed, heavy reliance on government support is likely to lead to a distorted emphasis on short-range, politicized research (Hoch, 1984:795).

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during the last hundred years was a further step in the consistent application of subjectivism" (Hayek, 1952:52).

The land grant university-USDA system in the United States makes it difficult for agricultural economists to avoid supporting policies that benefit dairy farmers, tobacco farmers, sugar interests, and other narrowly focused agricultural groups at the expense of the public at large. Rent seeking by agricultural economists is encouraged when the agency responsible for designing, administering, and evaluating the effects of government programs in agriculture also plays an important role in the financial support and coordination of research and education activities in agricultural economics (Pasour, 1988). However, further consideration of the relationship between the organization of research and education and the work agenda in agricultural economics, although highly important and largely ignored, is beyond the purview of this paper.

Conclusions

In conclusion, it is important to emphasize both what has been said and what has not been said. I have not said that current work in agricultural economics is unhelpful in understanding economic activity in the agricultural sector. Instead, my position is that although agricultural economists have made important contributions, there is a problem of balance and a shift in emphasis is warranted.

The discipline of agricultural economics appears to be ripe for change--at least in the United States. Prominent agricultural economists there have decried the increasing preoccupation with formalism and technique for the past quarter

century, urging that a broader approach be taken both in economic education and in economic analysis. However, thus far there has been little evidence of change in the bellwether outlet for agricultural economics in the United States, the American Journal of Agricultural Economics.

More work in two areas would help to improve the balance in agricultural economics. Additional stress on the operation of the decentralized entrepreneurial market process and on economics as a social science would add more realism to microeconomic theory and help to shift the emphasis of work in agricultural economics more toward choice between constraints. Doing so would help to illuminate a range of real world problems and issues that currently tend to be either overlooked or underemphasized in agricultural economics.

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MINISTRY OF AGRICULTURE AND FISHERIES
TE MANATU AHUWHENUA AHUMOANA

An

Intertemporal

Linear Programming Model

for

Pipfruit Orchard

Replacement Decisions

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Contents

1 INTRODUCTION

1.1 Background

The pipfruit industry in New Zealand has 922 orchards growing a mixture of apples and pears on 11,332 hectares in the year ending June 1990[13]. The industry is predominately an export industry with 75 to 80% of gross income earned by exporting. The FOB value of exports was over $214 million in 1990.

Pipfruit is a perennial crop with a physical life of between 20 and 60 years. However few trees reach the end of their physical life due to changing market requirements or technical advances.

Varieties need to change with changing market needs. Consumers may prefer red tart apples now and sweet green apples in 10 or 15 years. Markets may change due to political or economic forces.

Technical advances such as better rootstocks or training systems may mean that there are more profitable options available than the current trees in the ground.

Currently the main factor affecting the profitability of pipfruit is the range of market prices between varieties. Prices to the grower range three fold from a low of $6 per Carton Equivalent (CE) to $18/CE.

Although there are other factors impacting on profits, the price received is a major determinant of profits. With such a range of prices there is considerable scope for improving profit by choosing the optimal variety mix.

1.2 Objective and outline of paper

The objective of this paper is to develop a means to determine the optimum variety structure for a pipfruit orchard over time, taking into account price changes in the future. With crops that take 8 to 10 years to mature, it is all too easy to pay too much attention to current prices.

The optimum variety mix is that combination of varieties that makes the best use of resources and maximises profit.

The report will firstly describe the technique used to model this problem and the alternatives available. Next it will describe the structure and components of the model. Then the results will be analysed showing the effect of key changes in parameters. Finally, conclusions about the reliability of the model and results will be discussed as well as directions for future research.

2 Method - Choice of technique and the model

2.1 Choice of technique

The technique used should be chosen for reasons related to the situation to be modelled and/or practical limitations such as data limitations or processing constraints . Choosing a model because one is familiar with it is similar to forcing facts to fit a theory.

The technique should be able to model the main features or parameters that are present in reality. The main features to cover are :

- cashflows over time
- constraints on some resources,
- to be able to separate out certain parts of the orchard
- model both planting and removal.

The technique should handle as many factors endogenously as possible rather than require extensive outside input.

2.1.1 Alternatives that could be used

There are a variety of techniques available (see Kennedy[1] for more details). The most commonly used techniques have been ; comparison of annual returns using equivalent annuities, Intertemporal Linear Programming, and Dynamic Programming.

The simplest technique to apply is Equivalent Annual Returns of new plantings compared to existing plantings as discussed by Faris[9]. However this technique only works for whole orchards or blocks. The block to be removed must be selected before applying the technique. Also it does not explicitly take into account any constraints on resources.

Oppenheim[2] modeled restructuring pipfruit orchards in Nelson, NZ in the late 1970's. His conclusions were that it would take 10 years to redevelop at the prices prevailing at the time. The model had numerous activities aside from replanting, such as interplanting and regrafting. However, the number of age groups was restricted to 3 classes.

Willis[3] found that Intertemporal Linear Programming was a viable tool for making decisions and adding value to present knowledge. Their model included storage and capital constraints but grouped varieties into 5 age classes and only broke the harvest period into 2 stages.

Childs[11] developed a Dynamic Programming model that looked at the best type of tree planting system to maximise profits over time. Their model did not consider different varieties, or harvest constraints and had a minimum area of 0.4 hectare.

Linear Programming offers significant advantages over other methods in terms of the information provided for analysis.

Analysis of the dual solution provides Marginal Value Products which gives the value of adding or subtracting one additional unit.

Sensitivity analysis is also an option in most Linear Programming packages. This gives the range over which the optimal solution remains valid.

There is Linear Programming software available ready for use "off the shelf". A Dynamic Programming model on the other hand would have to be programmed from scratch.

The model was solved using BEELINE PRO on a PC.

2.1.2 Effect of LP assumptions on suitability to replacement decisions

Although Linear Programming is a powerful technique, it has a number of features that may limit suitability in terms of accuracy and consistency. The assumptions that must be valid for LP to be a viable technique and the impact on orchard replacement decisions are :

1) Linear

A problem must be linear in both constraints and objective function for a linear programming approach to be valid. The property of linearity is usually discussed as two components :

(a) Additive

Use of resources and output must be the sum of activities. There can not be any cross products between resources or products. There can be no economies of scale or synergistic effects for example , nor can price be affected by increasing supply.

This assumption is fulfilled provided the size of the property is constrained to an individual orchards existing area. Individual varieties variable income and expenses can be added together without any cross products.

Provided the size of the property is not increased, there are no additional capital costs needed to handle increased crop. Overheads will remain constant at a similar scale of production.

An individual orchard can not affect market prices by increasing or decreasing supply. It is a price taker

(b) Proportion (or Multiplication)

The proportionality constraint requires that an activity can be added to or subtracted from the objective function at will without incurring any

start up or close down costs.

This implies in particular that there are no increasing or decreasing returns to scale - ie one ha of Braeburn will be as productive as 10 ha on a per hectare basis. Another area where this could be potentially limiting in this case is in packing facilities. The cost per unit can vary considerably with scale.

In practice these can be avoided as limits by using upper and lower bounds on these factors. Area can be restricted to a maximum preferably close to the original orchard area. Packing capacity can be limited to a minimum and maximum through put that matches the realistic capacity and working requirements of the orchard.

2) Continuous variables

In the case of pipfruit, it is possible to have fractions of a hectare.

3) Certainty

The model deals with events over time. As such the results are not certain.

However, while the results of the model is not perfect, some knowledge is better than none. If necessary the model could be adapted to take risk into account through the MOTAD procedure.

2.2 Model Structure

2.2.1 Activities

(a) Area Planted

The main activity is the number of hectares of a particular variety planted in each year. The model can allow new planting in year 1. It must also be able to handle removal of area by different age groups of a variety.

The activities or decision variables are:

NP_{1j}^{t} = Area(ha) of New Plantings of variety j at the beginning of year t in age class 1

A_{ij}^{t} = Area(ha) of age group i of variety j at the end of year t **after** removals have been deducted

for i = 1, 2,... n age groups
j = 1, 2,... k varieties
t = 1, 2,... 20 years

Trees are divided up into 11 different age groups - years 1 to 11. Year 11 is taken as mature trees. Each age group has different cashflows and yields associated with it. Hence removal of different ages can have a different effect on the objective function. The model must be able to choose between removing a hectare of 3 year old trees vs a hectare of 4, 5, 6... year old trees.

This is one of the major differences between the model developed by the author and the model developed by Oppenheim[2]. The latter confined the age groups to 3 classes - non bearing, young but producing and mature trees. This grouping is too coarse when a 10 year decision range is used. The returns and costs have to be averaged over each period which can lead to serious distortions when the solution is assessed using the NPV of **each year.**

(b) Weekly harvest

A major feature of variety structure decisions for apple orchards is the need to spread the harvest evenly over a period. Growers are very aware of this point. The purpose of spreading harvest is to reduce risk and cost.

Income could be maximised by planting all the orchard in one variety. However the level of risk in this strategy is very high. The risk is that the preferred market variety will change suddenly. In this case a grower with only one variety would lose a large amount of money and may even be put out of business. Therefore growers prefer to have a mix of varieties to reduce market risk.

The harvest activities are the amount of each variety's production harvested in a particular week. The harvest period is split into 15 weekly intervals. A variety will only be harvested over 3 to 5 weeks. The algorithm must select the optimum quantity to harvest each week for each variety to maximise profits subject to harvest capacity constraints.

The harvest activities are expressed as:

Q_{wj}^{t} = Quantity harvested in week w for variety j in year t

for w = 1, 2,.. y weeks

This activity was only included for 2 years - 1993 and 2000 - to reduce the computational burden. It was assumed by the author that forcing the model to incorporate these activities at the start and finish of the planning period would bring an adequate measure of realism into the solution. It was felt that adding more harvest activities into the model would increase the time required to solve the model with little material improvement in accuracy.

2.2.2 Objective function

The objective function is to maximise the Net Present Value (NPV) of the stream of income generated by planting and replanting the optimal mix of pipfruit varieties over 20 years.

This can be expressed as :

$$\text{Maximise } Z = \Sigma R^{t}\alpha$$

$$R^{t} = \sum_{t} [\sum_{ij}(A_{ij}^{t} * GM_{ij}^{t}) - FC^{t}]$$

where R^{t} = Net return resulting from the A_{ij}^{t} planting decisions

A_{ij}^{t} area planted for each age group and variety (defined above)

GM_{ijt} = Gross Margin for age class i for variety j in year t

FC^{t} = Fixed Costs in year t

Varieties can only be removed and/or replanted in the first ten years. The objective function is however taken over 20 years. The author believes this is the best way to handle residual values with falling product prices and long lead in times.

The normal approach as recommended by Rae[8], and Oppenheim[14] is to specify an objective function that is the sum of the cash flows in the planning horizon plus the residual value at the end of the period. Residual values are typically calculated by capitalising the final years net benefits.

The model used in this analysis lets the cashflow effects of decisions made in the first ten years ripple through a following 10 year period. However, no area changes can occur after year 10.

With long lead in times required for apple production, new plantings may not be in full production by year 10. Therefore, it is important to let the actual effects be included rather than capitalise the net profit at year 10.

The model does not have a residual value. Freezing the value at the end of the project by using a capitalisation formula freezes returns at a high level. This leads to an over planting of those varieties that have high prices at the end of the period (even though they would be expected to continue to decline in real life after the project life) compared to those varieties that have more stable prices.

It was decided to restrict the planning horizon to 20 years and keep the deficiencies or weaknesses of the model obvious. the alternative is to include a residual value which would hide the faults of the model with spurious accuracy.

2.2.3 Constraints

The constraints used in the model are :

* maximum area of land available
  The orchard has a maximum size that can not be surpassed. This is expressed as :

$$A^t = \sum_j A_j^t \leq \text{Total Orchard Area}$$

where A^t is Area Planted in year t

* non negative planted area
  These constraints are logical constraints that prevent the model from removing more area than is planted. They can be expressed as :

$$NP_{1j}^t \geq 0$$

$$A_{ij}^t \geq 0$$

* minimum investment per year
  It is unrealistic to have a 20 year orchard model without allowing for investment for economic depreciation. At some stage over that period there must be some money spent on the orchard. It may be to replace plant and machinery or upgrade drainage or irrigation. This constrain is expressed as:

$$R^t \geq MC$$

where MC is the minimum cashflow required.

* harvest capacity
  The model must harvest all the fruit that is produced. This is expressed as :

$$\sum_w Q_{wj}^t = Q_j^t$$

and $$Q_j^t = \sum_i Y_{ij}^t$$

where Q_j^t = Quantity harvested of variety j in year t

Y_{ij}^t = Yield of age group i for variety j in year t

There are 3 constraints applied to each harvest year to ensure an even spread of harvest within the available harvest capacity.

- maximum weekly throughput

$$Q^w \geq \text{maximum feasible weekly capacity}$$

- minimum weekly throughput

$$Q^w \leq \text{minimum feasible weekly capacity}$$

- maximum variation from week to week. This is to stop large variations in weekly throughput.

$$Q^s \geq Q^{s-1} + QV \quad \textbf{or} \quad Q^s \leq Q^{s-1} - QV$$

$$QV = Q^{s-1} * \%V$$

where $Q^s = \Sigma Q_j^s$
= Total Quantity harvested in week s

QV = Maximum variation in quantity harvested between weeks

%V = Maximum percentage variation between weeks

for s = 2,3.. y weeks

The aim of these constraints is firstly to force the optimal solution to plant a spread of varieties rather than one or two highly profitable varieties. Secondly, to prevent dramatic swings in production which would be physically difficult to accommodate.

Spreading harvest over 3 months rather than 1 month means that only a third of the amount of capital is tied up in harvest facilities. It is also easier to attract staff if 3 months work can be offered instead of 1. Management and training of staff is also much easier.

Attaining an even spread of harvest is just as important as having an extended period. It is important in terms of retaining staff to provide work relatively evenly over the harvest period. If there are gaps in the harvest program with no work, then workers tend to go to other jobs and are not available when needed again.

The harvest constraint therefore is a proxy for both harvest facilities and labour supply constraints.In the current economic climate in NZ, there is adequate labour available for orchard work. If the harvest schedule is relatively even then the author has assumed that the supply of labour is not a constraint.

2.3 Data used

The initial starting point for the model is based on a typical model in Nelson. The source of the information is various pipfruit monitoring reports [17].

The data is split into gross margins by variety and overhead or fixed costs.

The gross margins are based in 10 year development budgets drawn up for a range of varieties for a typical orchard in Nelson. Typical production levels are used for yield and packout. Only costs that vary by planted area are included in the Gross Margins.

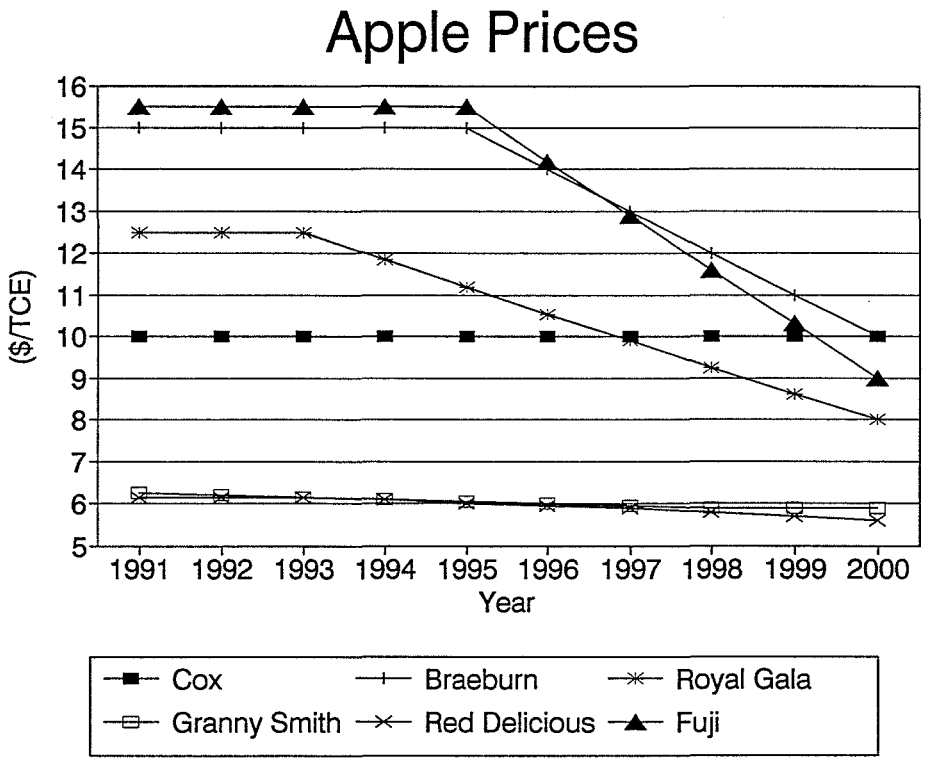
Costs are those applying in December 1990.

Overhead costs includes operational overheads, plus drawings and existing debt servicing.

Tax is not included in this model, nor does the model allow for new borrowing to finance replanting. Initial tests showed that tax and new borrowing did not affect the final orchard structure. The affect of adding these two factors was to reduce the objective function and insome cases delay replanting. Including these two factors would have increased the complexity of the model but not helped the objective of assessing the effect of price change on orchard structure.

Apple prices are based on a national average price of approximately $8/CE in the first year. They are long term prices rather than current market prices.

Prices are assumed to reduce over the following 10 years at different rates for each variety to allow for increasing world supplies. Prices are assumed to stabilise for the remaining 10 years.



3 RESULTS

3.1 Varieties removed and rate of change

The initial values for the model in 1991 and the final values in 2000 are :

Variety	Area (ha)		Change		Gross Margin
	1991	2000	(ha)	(%)	($/ha NPV)
Coxs Orange	1.90	1.90	0		52,200
Royal Gala	0.90	0.76	-0.14	-15	56,500
Golden Delicious	0.40	0.00	-0.40	-100	-2,900
Premier Red	0.60	0.31	-0.29	-48	15,000
Braeburn	2.00	4.10	2.10	105	102,400
Fuji	0.50	0.84	0.34	68	65,500
Red Delicious	0.80	0.00	-0.80	-100	5,600
Sturmer	0.60	0.60	0		38,600
Granny Smith	2.00	0.86	-1.14	-57	22,200
Red Dougherty	0.30	0.50	+0.20	60	11,800
TOTAL AREA	10.00	10.00	0		
Objective function (NPV)		$590,900			

Profit per hectare is the driving motive for changes. The main increases in area is in Braeburn and Fuji, which also have the highest Gross Margin as measured by the Net Present Value per hectare.

Braeburn increased the most (105%) as it is the most profitable.

The harvest constraint as it was set up in the model caused some unusual results at the end of the season. Red Dougherty area was increased because of minimum fluctuation requirements. The profitability of this variety would not suggest that additional area should be planted.

Fuji was not planted as much as profit would suggest. The requirement to minimise fluctuations in weekly harvest kept the area planted low. Also the model preferred to plant more Braeburn as it was more profitable than Fuji.

The harvest constraints do not invalidate the model. However,

they would need to be adapted to individual situations very carefully.

The main decreases are the complete removal of Golden Delicious and Red Delicious.

Golden Delicious is not surprising as it is a loss maker. Red Delicious is the next lowest in profit after Golden Delicious and is totally removed in the first year. Although it has a positive gross margin, it is unlikely to cover its overheads fully.

Red Delicious was also completely removed. This is faster than growers are currently happy with. However, the low profit used in this model leaves no other choice. It is mainly replaced with extra Braeburn.

Sturmer remained unchanged due to reasonable gross margin. The price outlook for Sturmer is much better now than was the case 3 years ago.

Royal Gala, Granny Smith and Premier Red area declined but not totally. The factor preventing complete removal was different in each case.

The removal of Royal Gala is surprising on first appearances as it has a high Gross Margin and is one of the new varieties much sought after by the markets. However, there is a constraint on packing capacity in the start of the season the way the model is structured. Some area of Cox or Royal Gala would have to be removed to meet the harvest constraint.

The area removed of Royal Gala was one year old when it was removed. Young blocks are the first to be removed as there is a delay till full production that reduces the Gross Margin significantly.

The price used as a base in this analysis is lower than many growers are currently using. It also decreases in the next 10 years whereas Coxs is assumed to remain unchanged. This would favour young Coxs to retained in the place of Royal Gala.

Premier Red was retained even though it has a very low gross margin per hectare. The gross margin would be less than overheads so the orchard would make a loss from growing them. However, it is the only practical way to satisfy the harvest requirements in the mid season. If Premier Red was not packed there would be a gap of a week with nothing harvested. This would be a violation of the minimum weekly harvest throughput and unacceptable by growers.

Granny Smith area declined slightly (6%) in year 1, and declined further in year 10. The initial decline is due to switch away to Braeburn due to higher profits. The later reduction in area is caused by maximum harvest constraints applying in year 10. Due to size restrictions, the harvest constraints are only applied in years 3 and 10.

The general trend is to reduce production of Granny Smith. It is however, surprising that more Granny Smith was not replaced by Fuji. The harvest constraints discussed previously have affected the area that can be planted in Fuji, as would the assumed price fall over the period of analysis.

Overall, the author consider the model gives similar answers to what is happening in practice[17]. Growers are removing mainly Golden Delicious, Red Delicious and Granny Smith. Replacements are mainly Braeburn and Fuji.

The model differs from current practice in some aspects. However the author believes that this is mainly due to different price perceptions held by growers to that used in this paper. The harvest constraints may also be too inflexible compared to a commercial packing operation.

3.2 **Sensitivity Analysis**

3.2.1 Discount rate

The base analysis used a 15% discount factor. As the analysis was done in real terms, this is equivalent to a very high nominal discount rate of say 18% in 1991. This is double the risk free rate which is 8.8% to 9% (November 1991)

Market risk premiums were reported by Bell[18] to range from 6 to 8.5% in New Zealand. This is similar to the long term average risk premiums reported in Brealey and Myers[19] of 8.4% (Treasury Bills compared to Sharemarket).

Although investors may require such a margin for the risk involved in Pipfruit orchards, the model was rerun with a lower discount rate of 10% and 5% to see if the final structure varied significantly from the base.

The main effect of the lower discount rate was to encourage earlier replacement. Granny Smith area in particular changed more dramatically - it went down 50 % in the first year for the 10% real rate, instead of 6% in the base analysis.

The effect of a lower discount rate is to value later benefits more than with a high discount. Therefore the model orchard would be prepared to accept a greater loss in income now by faster replacement than with a higher discount rate.

The 10% rate led to minor changes. Royal Gala did not decrease as in the base option. Premier Red decreased to make up for Royal Gala remaining the same.

There were more significant changes with a 5% rate. Braeburn area increased 27% over the 15% scenario. This was at the expenses of Sturmer, Fuji, Granny Smith and Red Dougherty.

Variety	Area (ha)			
	Start	End		
Discount rate		15%	10%	5%
Coxs Orange	1.90	1.90	1.90	1.90
Royal Gala	0.90	0.76	0.90	0.90
Golden Delicious	0.40	0.00	0.00	0.00
Premier Red	0.60	0.31	0.31	0.31
Braeburn	2.00	4.10	4.10	5.23
Fuji	0.50	0.84	0.84	0.63
Red Delicious	0.80	0.00	0.00	0.00
Sturmer	0.60	0.60	0.60	0.00
Granny Smith	2.00	0.86	0.86	0.65
Red Dougherty	0.30	0.50	0.50	0.38
TOTAL Area (ha)	10.00	10.00	10.00	10.00
Net Present Value ($)		590,900	866,900	1,647,800

Growers current practices are more in line with the lower rates of 5 and 10%. If the only difference is the required rate of return, then it may be more appropriate to use a lower real rate of return for further analysis.

3.2.2 Effect of starting variety mix

If the conclusions from one analysis could be applied through out the whole industry, there would be considerable savings in the cost of preparing information. To test this hypothesis, an orchard with a poorer variety mix at the start of the analysis was tested.

This orchard started with a much poorer variety mix than the base. There are no Fuji or Royal Gala planted at all in this scenario. The proportion of Granny Smith and Red Delicious is much higher at 58% compared to the base analysis of 28%.

The end variety mix is not the same as the base model although the direction of movement is the same. The poorer orchard ends up with more Braeburn than the base but no Royal Gala. Apparently the poorer orchard would have missed the high prices for Royal Gala and it would not be feasible to plant any more.

Variety	Area (ha)		Change		Gross Margin
	1991	2000	(ha)	(%)	($/ha NPV)
Coxs Orange	1.14	1.25	0.11	10	52,200
Royal Gala	0.00	0.00			56,500
Golden Delicious	1.30	0.02	-1.28	-98	-2,900
Premier Red	0.14	0.07	-0.07	-50	15,000
Braeburn	0.90	5.87	4.97	550	102,400
Fuji	0.00	0.53	0.53	100	65,500
Red Delicious	1.62	0.96	-0.66	-41	5,600
Sturmer	0.76	0.76	0		38,600
Granny Smith	4.14	0.54	-3.60	-87	22,200
Red Dougherty	0.00	0.00		60	11,800
TOTAL	10.00	10.00	0		
Objective Function (NPV)		$400,600			

There was more Granny Smith removed and less Red Delicious removed than in the base analysis. There is a lower proportion of early varieties in the poorer scenario. The orchard did not plant any Royal Gala as the profitability was too low. However, it still needed Red Delicious to maintain the harvest flow

On the other hand Granny Smith could be replaced with Braeburn and not be affected by harvest continuity constraints to the same extent.

The general trends of the type of varieties being removed remained the same for a poorer variety mix. However, the speed and extent of a variety change varied significantly. Therefore the starting position of individuals can have a significant effect on the final structure of the orchard. Growers would be advised to adapt the general trends to suit their own conclusions.

3.2.3 Harvest restrictions

There are two forms of constraints used for the harvest section:

(a) Maximum and minimum production that could be handled per week (4,500 and 1,500 respectively)
(b) Maximum variation in harvested production from one week to the next of 25%

The way harvest constraints were applied had a major effect on the final variety mix in the base solution. From examining the dual values it appeared that the objective function would increase significantly if the maximum variation per week was

increased from 25 to 50%.

The actual results showed that there was a minimal improvement in objective function but a significant change in the variety mix.

There was more Fuji planted and less Granny Smith removed. Braeburn area did not increase as much as the base scenario. Royal Gala was not removed but the area of Premier Red was reduced further. Red Dougherty area was reduced rather than increased.

Variety	Area (ha) in 2000	
Maximum weekly harvest variation	25% (Base)	50%
Coxs Orange	1.90	1.90
Royal Gala	0.76	0.90
Golden Delicious	0.00	0.00
Premier Red	0.31	0.27
Braeburn	4.10	3.14
Fuji	0.84	0.97
Red Delicious	0.00	0.00
Sturmer	0.60	0.60
Granny Smith	0.86	1.83
Red Dougherty	0.50	0.38
TOTAL AREA	10.00	10.00
Objective function (NPV)	$590,900	$595,100

The net effect is to give a variety mix more in line with current grower practise.(Not many growers would be removing Royal Gala and planting Red Dougherty).

The implication is that the base solution may have been too strict on maximum weekly fluctuations that growers are prepared to tolerate. Each individual case should evaluate this parameter carefully.

3.3 Value of simplifying the model

The model as formulated is large and takes a long time to solve (2 to 4 hours).

The normal way to reduce the size of an LP to one that can be solved by available hardware or software is to reduce either the number of constraints or activities. However as Schragge [15] points out reducing the number of activities can lead to infeasible solutions. Reducing the number of activities can lead to non-optimal solutions.

Previous work with Intertemporal Linear Planning has tended to reduce the number of activities by amalgamating individual years into groups of years. For example, Oppenheim[2] uses 4 age groups (0-5, 6-20, 21-50 and 50+). Using the same grouping would have reduced the number of activities and the number of constraints by 73%, which would have doubled the solution speed.

However Oppenheim's final results were not practical. The base option used by him (A1) had annual cash losses for 9 out of the 10 years analysed. The operator would have had to work off the orchard full time for 5 years at least to make the plan work.

Some of the pessimistic results would be due to low prices and the poor outlook for the industry prevailing at that time. However, the author believes that using such broad age groupings severely misstated the economics of changing varieties and consequently recommended plans that would not be suitable. Growers would not be prepared in general to work off the orchard for 5 years. They might as well sell the orchard and work full time else where.

4 CONCLUSIONS

Intertemporal Linear Programming is a viable method of modelling the optimum variety structure over time for a pipfruit orchard. However, the level of detail required to model the orchard pushes software and hardware to the limit on a PC. The model can be solved but it takes a long time (2 to 4 hours). Advances in computer technology will allow faster solution times in the future.

The model as set out does give similar results to what growers are currently doing. However the model gives more information and allows sensitivities to be run to test assumptions.

The present constraints of minimum cash requirement, maximum orchard area , harvest constraints and not removing more than is planted in any one year give realistic answers. To be fully realistic, the model should include the ability to borrow and tax in the cashflows. The main effect of these would be on the minimum cashflow produced and hence on the speed at which changes would be made.

Harvest constraints are an area that requires careful adaption to each individual situation. Growers want to see a flow of fruit evenly through the harvest season. Planting all the orchard in one variety is not an acceptable alternative.

However, the model shows that operational needs such as maintaining a steady flow of fruit can have severe effects on cashflow. The analyst using this approach should be particularly careful what harvest constraints are used and what the effect might be of relaxing them.

Many models amalgamate activities to reduce the problem to a level that is possible to solve on their available hardware and software. This practice is fraught with dangers as it can produce an optimal solution that looks satisfactory but may well be some distance from the real optimum.

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Variety Fuji

	Year	GM/yr	0	1	2	3	4	5	6	7	8	9	10	11		Production
					Age Structure											
Start le	Year 0, May 31			0.07	0.12	0.12	0.09	0.07	0.02	0.01	0	0	0	0	0.5	365
1991	Opening Area, June 1		0.335913		0.07	0.12	0.12	0.09	0.07	0.02	0.01	0	0	0		
	Min area constraint				6.37E-14	1.09E-13	1.09E-13	8.19E-14	6.37E-14	1.82E-14	9.1E-15	0	0	0		
	Planted Area, May 31	171		0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01	0	0	0	0.835913	610
1992	Opening Area		0		0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01	0	0		
	Min area constraint				0	0	0	0	0	0	0	0	0	0		
	Planted Area	6,329		0	0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01	0	0	0.835913	892
1993	Opening Area		0		0	0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01	0		
	Min area constraint				0	1E-10	0	0	0	0	0	0	0	0		
	Planted Area	8,402		0	0	0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01	0	0.835913	1,360
1994	Opening Area		0		0	0	0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01		
	Min area constraint				0	0	0	0	0	0	0	0	0	0		
	Planted Area	9,461		0	0	0	0.335913	0.07	0.12	0.12	0.09	0.07	0.02	0.01	0.835913	1,605
1995	Opening Area		0		0	0	0	0.335913	0.07	0.12	0.12	0.09	0.07	0.03		
	Min area constraint				0	0	0	0	0	0	0	0	0	0		
	Planted Area	9,582		0	0	0	0	0.335913	0.07	0.12	0.12	0.09	0.07	0.03	0.835913	2,219
1996	Opening Area		0		0	0	0	0	0.335913	0.07	0.12	0.12	0.09	0.1		
	Min area constraint				0	0	0	0	0	0	0	0	0	0		
	Planted Area	9,877		0	0	0	0	0	0.335913	0.07	0.12	0.12	0.09	0.1	0.835913	2,578
1997	Opening Area		0		0	0	0	0	0	0.335913	0.07	0.12	0.12	0.19		
	Min area constraint				0	0	0	0	0	0	0	0	0	0		
	Planted Area	10,396		0	0	0	0	0	0	0.335913	0.07	0.12	0.12	0.19	0.835913	2,678
1998	Opening Area		0		0	0	0	0	0	0	0.335913	0.07	0.12	0.31		
	Min area constraint				0	0	0	0	0	0	0	0	0	-2.3E-13		
	Planted Area	11,816		0	0	0	0	0	0	0	0.335913	0.07	0.12	0.31	0.835913	3,124
1999	Opening Area		0		0	0	0	0	0	0	0	0.335913	0.07	0.43		
	Min area constraint				0	0	0	0	0	0	0	0	0	0		
	Planted Area	12,778		0	0	0	0	0	0	0	0	0.335913	0.07	0.43	0.835913	3,240
2000	Opening Area		0		0	0	0	0	0	0	0	0	0.335913	0.5		
	Min area constraint				0	0	0	0	0	0	0	0	0	-2.3E-13		
	Planted Area	13,307		0	0	0	0	0	0	0	0	0	0.335913	0.5	0.835913	3,335

= Activities

Variety Year 1993

	Week - number	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total		Upper
	- date of first day	11-Feb	18-Feb	25-Feb	04-Mar	11-Mar	18-Mar	25-Mar	01-Apr	08-Apr	15-Apr	22-Apr	29-Apr	06-May	13-May	20-May			
Coxs		2165	2731	2048	0	0	0	0	0	0	0	0	0	0	0	0	6965	=	6965
Royal Gala		0	0	0	2208	502	0	0	0	0	0	0	0	0	0	0	2710	=	2710
Premier		0	0	0	0	2257	0	0	0	0	0	0	0	0	0	0	2257	=	2257
Braeburn		0	0	0	0	0	3449	4312	0	356	27	0	0	0	0	0	8116	=	8116
Fuji		0	0	0	0	0	0	0	0	0	0	0	1360	0	0	0	1360	=	1360
Granny Smith		0	0	0	0	0	0	0	4500	3228	0	2000	0	0	0	0	9728	=	9728
Red Delicious		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	=	0
Sturmer		0	0	0	0	0	0	0	0	0	2640	0	0	0	0	0	2640	=	2640
Golden Delicious		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	=	0
Red Dougherty		0	0	0	0	0	0	0	0	0	0	0	140	1500	0	0	1640	=	1640
Total harvest per week		2165	2731	2048	2208	2760	3449	4312	4500	3556	2667	2000	1500	1500	0	0	35415		

= Activities

MAXIMUM CAPACITY

Weekly throughput - maximum	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500		
- surplus capacity	2315	1769	2452	2292	1740	1051	188	0	944	1833	2500	3000	3000		

MINIMUM CAPACITY

Weekly throughput - minimum	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500		
- surplus capacity	665	1231	548	708	1260	1949	2812	3000	2056	1167	500	-0	0		

HARVEST VARIATION

Maximum Deviation %	0.25 of previous week	546	683	512	552	690	862	1078	1125	889	667	500	375		
CONSTRAINTS															
Absolute deviation - minimum		-0	1366	353	-0	0	-0	890	2069	1778	1333	1000	375		
- maximum		1092	0	671	1104	1380	1725	1266	181	-0	-0	-0	375		

AGRICULTURAL ENTERPRISE GROSS MARGINS:

A SUGGESTED METHODOLOGICAL IMPROVEMENT FOR COMPARISONS

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Abstract

A computer model which simulates grazing management was used to study the effects of gross margins per hectare upon the relative ranking of beef breeding cow enterprises compared to bull beef production, and breeding ewes. The use of standard stock units for financial comparisons is shown to cause misleading results when used as the basis for comparing gross margins. However when gross margins are calculated per hectare to include the effects of pasture utilisation, dairy crossbred cows are shown to be less profitable for beef production than purebred beef cows. At high levels of pasture utilisation breeding cows can be almost as profitable as bull beef production.

Approach

In a survey of sheep and beef farmers of Waitomo County in early 1992, some expressed concern at the manner in which the profitability of alternative cattle enterprises was being calculated and used to encourage major farm enterprise changes. Specifically they were being advised to replace breeding cow policies with finishing bull beef enterprises, based upon gross margin analyses.

In order to incorporate some of their concerns, gross margins were calculated for a range of breeding cow options. Two examples are included in this paper. Gross margins were also calculated for bull beef and breeding ewes; average to above average animal performances were assumed.

Gross margins for the beef cow policies (Appendix) include revenue from calves sold at weaning (nett of sale costs), surplus unmated heifers sold to the local meat trade, cull aged cows, and a proportion of an aged breeding bull. Direct costs included purchase of female replacements (where required) and a replacement bull. Freight costs directly related to animal movements on and off-farm are included, as were animal health costs for drenching young animals and for veterinary call outs at calving. No costs for supplementary feed were required.

Capital investment was treated in a manner that reflects its relevance to the majority of the farmers concerned. Not all farmers need overdraft facilities to service livestock purchases, but where they do, this cost is an important part of their decision making (unpublished Te Akau Farm Monitoring Report, August 1991). In this study it was assumed that all purchases were made annually from bank overdraft and this was not repaid until twelve months later.

Gross margins were compared in two ways. The gross margins per stock unit were calculated using standard stock units for financial analyses. One stock unit being equivalent to the feed requirement of a breeding ewe rearing 0.95 lambs until weaning (MAF Economics, Farm Costs and Prices, Appendix I). Gross margins per hectare are calculated from the number of breeding animals (and their replacements) able to be stocked per hectare. To determine this each enterprise was modelled using the Stockpol computer program (Marshall, P.*et al*, 1991; McMillan, W.H. *et al*, 1992) to calculate the amount of available pasture needed on an annual basis; and the maximum proportion of feed grown that could be consumed by livestock. If an enterprise had a "poor fit" to available pasture then unavoidable pasture wastage resulted.

"Annual pasture allowance" (Table 1) consists of more than just the amount of feed consumed. Animal intake tends to increase with increasing amounts of pasture being offered for grazing as the feed becomes more accessible. However, the amount of pasture left ungrazed will also increase and this will result in pasture wastage being built into the grazing system. The amount of pasture wasted is included with animal intakes to become annual pasture allowance.

Pasture utilisation is the ratio of the amount of pasture that can potentially be grown and the actual amount consumed by livestock. A high pasture utilisation, without overgrazing, maximises pasture growth and converts productivity investments, such as fertiliser into animal product, and so, income.

If pastures are overgrazed they become open, pasture composition reverts and pasture production rapidly declines. If pastures are undergrazed then rank areas revert to poorer pasture species and brush weeds, and again pasture production declines. Different land classes and livestock enterprises have different optimum levels of pasture utilisation. Enterprises such as fast growing yearling bulls and dairy beef crossbred breeding cows require lower levels of pasture utilisation (60-70%), than traditional beef cows and breeding sheep policies (70-80%), if the former are to achieve target live weights.

The seasonal pasture production pattern used in this study is typical for a North Island moist summer, easy hill country property, producing 10,000kgDM per hectare per annum (there will be differences with other parts of New Zealand).

Results and Discussion

In Table 1 the relationships between standard stock units and relative annual pasture allowance are shown. A traditional beef breeding cow policy where heifers are first mated at 26 months of age and growing its own replacements is compared to a more recently promoted (NZ Beef Council Proceedings, 1989) breeding policy using dairy beef crossbred cows first mated at 14 months of age. The dairy beef cows are subsequently mated to a large fast growing bull breed; all of the calves sold and replacement females bought in.

Standard stock units for financial analyses were used to calculate the number of stock units of each adult animal unit (adult plus replacement) for each livestock enterprise shown in Table 1. Differences in standard stock units appear closely related to differences in annual pasture intake. Annual pasture allowance is a result of animals being grazed so that they leave residual pasture behind in order to achieve their intake targets. Residual pasture results in wasted potential feed which is included with actual animal intake to calculate allowance. Whilst the difference in stock units between policies reflects differences in intake, it under estimates the increase in annual feed allowance actually required for increased productivity. This can be seen by comparing the standard stock units and relative annual pasture allowances for the two breeding cow policies. Extra feed required for growing pregnant yearling dairy beef crossbred heifers increases their intakes and especially their allowances sharply.

Table 1: Stock Units and Annual Allowance*

Livestock Enterprise	Standard Stock Units (su/adult wintered)	Annual Pasture Intake (kgDM/adult)	Annual Pasture Allowance (kgDM/adult)	Relative Annual Pasture Allowance (Bdg ewe=1.0)
Traditional breeding cow (mating at 26 months, selling all surplus weaners)	7.9	3,880	5,155	6.0
Dairy beef crossbred cow (mating at 14 months, selling all surplus weaners)	8.7	4,361	7,042	8.3
Breeding ewe (95% lambing)	1.3	677	850	1.0
Friesian bull (selling at 19 months of age at 256kg carcass weight)	5.0	2,678	3,745	4.4

* Includes breeding animals and their replacements

The stocking rates shown in Table 2 are at their maximum biological feasibility. They take into account different levels of allowance (or pasture utilisation) needed to achieve the desired level of animal production. A sheep enterprise can achieve a higher level of pasture utilisation than is possible for breeding cows and bulls. Therefore the highest stocking rate (standard stock units per hectare) is that for breeding ewes.

Pasture utilisation has been calculated from Table 1. The high utilisation possible for breeding ewes and traditional breeding cows results in them being ideally suited to the grazing management needed to maintain pasture production.

The effects of differences in pasture utilisation results in different enterprise rankings for gross margins per stock unit and gross margins per hectare shown in Table 3.

Table 2: Gross Margin Summary of Returns per Standard Stock Unit, and per Unit Area Using Relative Annual Pasture Allowance

Livestock Enterprise	Stocking Rate su/ha	Pasture Utilisation %	Gross Margin $/su	Gross Margin $/ha
Traditional breeding cow	15.4	75	35	543
Dairy Beef crossbred cow	12.3	62	43	536
Breeding ewe	15.7	80	31	493
Friesian bull	13.4	71	41	549

Table 3: Gross Margin Rankings*

Livestock Enterprise	Ranking by $/su	Ranking by $/ha
Traditional breeding cow	3	2
Dairy beef crossbred cow	1	3
Breeding ewe	4	4
Friesian bull	2	1

* "1" equals the highest ranking

If a farmer was being advised based upon gross margins per stock unit, a dairy beef breeding cow policy using large exotic terminal sires would be the one advocated. However when the greater stocking rate possible with bull beef is taken into account and the enterprises are compared on their gross margins per hectare, bull beef is again the highest returning enterprise. The most significant change in ranking though, occurs for traditional breeding cows, which can be farmed at higher levels of pasture utilisation than dairy crossbred cows and so achieve similar gross margins per hectare.

Many hill country farmers winter traditional breeds of cows on a high proportion of rank pasture and coarse weeds (Pleasants A.B., NZ Grassland Association 1991). When some of the animal's intake is made up of non pasture feeds it's apparent levels of pasture utilisation will be higher than those shown here, increasing gross margins ($/ha) even further to where they can be at least as profitable as any other cattle option.

Elsewhere it has been shown (Table 4) that policies that combine finishing cattle and breeding ewes involving complementary grazing can increase gross margin returns per hectare above those for either separate sheep or cattle enterprises. This is achieved by using complementary grazing to maintain stocking rates similar to sheep alone and yet still obtaining cattle liveweight targets.

Table 4:* Gross Margins for Separate and Mixed Breeding Ewe and Finishing Cattle Enterprises

Livestock Enterprise	Animal Performance Lambing %/carcass kg	Stocking Rate su/ha	Gross Margin $/su	Gross Margin $/ha
Sheep	80	19	28	426
	90	17	30	471
	100	15	32	516
	110	14	34	561
Bulls	229	19	24	453
	256	13	41	549
	272	10	50	524
Mixed Sheep & Cattle	80/229	21	26	546
(50:50)	90/256	18	36	639
	100/272	15	41	615
	110/272	14	42	588

*After Parminter T.G., 1992

If bulls are farmed to achieve the same pasture management results as those for traditional beef cows by maintaining pasture utilisation, their nett profitability drops away markedly (Table 5). This results in them being less profitable than breeding cow enterprise options.

Table 5: Effects of Pasture Utilisation Upon Animal Performance in Friesian Bulls

No. of bulls animals/ha	Stocking Rate su/ha	Pasture Utilisation %	Carcass Wt (kg)	Gross Margin $/su	Gross Margin $/ha
2.1	10.4	60	272	50	524
2.7	13.4	70	256	41	549
3.1	15.4	77	245	35	535
3.8	18.8	82	229	24	453

The indirect and opportunity costs of changing farm enterprises are such that none of the cattle gross margins shown here could, on their own, justify a change of cattle policy.

Enterprises that are established and managed to maximise their gross margin per stock unit will tend towards a reduced stocking rate and high performance per head (Table 5) pasture utilisation and performance per hectare will be lower as a result.

Conclusions

It is common practice to calculate gross margins per hectare by assuming stocking rates(su/ha) remain constant for all the enterprises being compared. Instead, the appropriate ratio of pasture utilisation should be used to adjust stocking rates between enterprises and so provide a more accurate indicator of likely relative returns on a per hectare basis.

The relationship between expected animal performances and annual animal allowance determines the level of pasture utilisation and therefore the stocking rate to be used for gross margins.

On properties where animals have a dual function to maintain and improve the pasture resource as well as to earn adequate farm income; enterprise mixes and animal performance predictions should be optimised with regard to that function. Such farm policies will result in more sustainable agricultural development. Enterprise comparisons based upon returns per stock unit are inappropriate in these circumstances.

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ASSUMPTIONS

Prices/Costs	1991/92				
Breed	Angus				
Calving(weaned)	92%				
Death & Losses	3%				
Cull-for-age (yrs)	12				
Replacements	Breed own				
	Ratio of 2yr/1yr Heifers		100%		
	Proportion of 1yr Matings		0%		
	Proportion ofHerd Replaced		20%		
	Proportion of 2yr Matings		100%		
Effective (cattle only) Grazing Area			50 hectares		
Stocking Rate is	1.9 cows per hectare or			15.4 su/ha	
Cost of capital	15 %				

Numbers at 1st July

Animal class	Number	su/head	Total su
R1yr Heifers	19	4.0	78
R2yr Heifers	19	5.0	97
M.A. Cows	97	6.0	583
Breeding Bulls	2	5.0	12
Total	138		769

REVENUE	Stock class		Number	C.Weight(kg)	$/head	Total
Stock Sales	Wnr calves		69	97	340	23600
	1yr Heifers		0	185	423	0
	2yr Heifers		3	225	549	1422
	M.A. Cows		13	180	386	5030
	Breeding Bulls		0	400	1069	441
Total Gross Income		$30,494		$40 \su		$610 \ha
DIRECT COSTS						
	Stock Purchases:	bulls		0.41	@ $4,000	
		Total	$1,650			
	Animal Health		$415			
	Freight		$1,028			
TOTAL COSTS(CASH BASIS)			$3,093			
	Capital cost of purchases $1650@ 15%		$248			
TOTAL (NETT OF CAPITAL COSTS)			$3,341			
GROSS MARGIN						
	Cash basis	$27401		$36 \su		$548 \ha
	Nett of capital cost	$27153		$35 \su		$543 \ha

ASSUMPTIONS

Prices/Costs	1991/92		
Breed	Hereford Freisian Crossbred		
Calving(weaned)	94%		
Death & Losses	3%		
Cull-for-age (yrs)	10		
Replacements	Breed own		
	Ratio of 2yr/1yr Heifers	85%	
	Proportion of 1yr Matings	100%	
	Proportion ofHerd Replaced	22.0%	
	Proportion of 2yr Matings	100%	
Effective (cattle only) Grazing Area		50 hectares	
Stocking Rate is	1.4 cows per hectare or		12.3 su/ha
Cost of capital	15 %		

Numbers at 1st July

Animal class	Number	su/head	Total su
R1yr Heifers	19	4.0	76
R2yr Heifers	16	6.0	97
M.A. Cows	71	6.0	427
Breeding Bulls	4	5.0	18
Total	110		617

REVENUE	Stock class	Number	C.Weight	$/head	Total
	Wnr calves	82	125	400	32836
	1yr Heifers	3	194	461	1313
	2yr Heifers	0	245	635	0
	M.A. Cows	14	194	418	5759
	Breeding Bulls	1	400	1069	655

Total Gross Income		$40,562	$66 \su		$811 \ha
DIRECT COSTS					
	Stock Purchases	bulls	0.6	@	$6,000
		calves	19	@	$360
		Total	$10,506		
	Animal Health		$330		
	Freight		$1,348		
TOTAL COSTS(CASH BASIS)			$12,184		
	Capital cost of purchases $10506@ 15%		$1,576		
TOTAL (NETT OF CAPITAL COSTS)			$13,759		
GROSS MARGIN					
	Cash basis	$28379	$46 \su		$568 \ha
	Nett of capital costs	$26803	$43 \su		$536 \ha

ASSUMPTIONS

Prices/Costs	1991/92		
Breed	Romney		
Lambing(weaned)	95%		
Death & Losses	3%		
Culling	5%		
Cast-for-age	5 years		
Replacements	Breed own		
	Proportion Wintered	95%	
	Proportion Retained	63%	
Effective (sheep only) Grazing Area		50 hectares	
Stocking Rate is	11.8 ewes per hectare or		15.7 su/ha
Cost of capital	15 %		

Numbers at 1st July

Animal class	Number	su/head	Total su
Ewe hoggets	268	0.7	188
MA ewes	595	1.0	595
Wether hoggets		0.8	0
Ram hoggets		0.7	0
Rams	11	0.9	10
Total	874		793

REVENUE	Stock class		Number	C.Weight	$/head	Total
Stock Sales	wthr/ram lbs	finished	192	16	30	5795
		store	82	12	22	1842
	ewe lbs	store	6	12	22	127
	R-2ths	cull	82		38	3078
	MA ewe	cull	25		15	368
		5-yr cull	136		12	1627
Total	$12,837					

		Number	Weight/hd	$/kg	Total
Wool Sales	lambs	565	1.00/kg	4.15	2346
	hoggets	268	3.50/kg	4.30	4029
	ewes	595	4.30/kg	4.00	10234
Total	$16,608				

Total Gross Income		$29,446	$37 \su		$585 \ha
DIRECT COSTS					
	Stock Purchases	rams	2	@	$200
		Total	$374		
	Animal Health		$774		
	Shearing & Crutching		$2,071		
	Freight		$1,304		
TOTAL COSTS (CASH BASIS)			$4,523		
	Capital cost of purchases $374@ 15%		$56		
TOTAL (NETT OF CAPITAL COSTS)			$4,579		
GROSS MARGIN					
	Cash basis	$24923 total	$31 \su		$495 \ha
	Nett of capital costs	$24867 total	$31 \su		$493 \ha

ASSUMPTIONS

Prices/Costs	1991/92				
Breed & Type	Friesian bulls				
Purchase at 6-7 months of age, sell at 16-19 months of age					
Death & Losses	3%				
Calf Liveweight		200 kg			
Final Carcass Wt		256 kg	Live Weight		489 kg
Average growth rate of		0.79 kg/head/day			
Effective (cattle only) Grazing Area			50 hectares		
Stocking Rate is	2.67 animals per hectare or			13.4 su/ha	
Cost of capital	15 %				

Numbers at 1st July

Animal class	Number	su/head	Total su
bull	134	5.0	668

REVENUE

Stock Sales		$96,981	Schedule	$3.00
			Income per head	$749

Total Gross Income	$96,981	$145 \su		$1,940 \ha

DIRECT COSTS

Stock Purchases	calves		134 @	$420
	Total	$56,070		
Animal Health		$2,058		
Freight		$3,010		

TOTAL COSTS (CASH BASIS)	$61,138
Capital cost of purchases $56,070 15%	$8,411
TOTAL (NETT OF CAPITAL COSTS)	$69,549

GROSS MARGIN

Cash basis	$35842	$54 \su	$717 \ha
Nett of capital costs	$27432	$41 \su	$549 \ha

REFLECTIONS OF EXPECTATIONS IN FARM MANAGEMENT DECISIONS

By
G. Frengley and C. Uriarte

The goals of farmers are not dictated by economics alone, and economic utility does not necessarily explain the farmer decision making processes. Perceptions about events (future, present or past), influence their decisions. We are continually confronted by the need to make decisions. Decisions lie at the heart of society in all its aspects; it is part of the human burden. We can choose only what is yet to happen from the figments of our imagination. Imagined actions and policies can have only imagined consequences, and it follows that we can choose only an action whose consequences are uncertain, since we cannot be an eye-witness to any of them. This introduces us to the world of expectations.

The role of expectations in the decision-making process effected by farmers is central to the discussion presented here. We start by defining expectations, its major characteristics and the theories which have been used to explain it. In the second part, the role of expectations in farm management decisions and the assessment of expectations is examined. A case study is used as an example.

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REFLECTIONS OF EXPECTATIONS
IN FARM MANAGEMENT DECISIONS

By
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I.- THE CONCEPT OF EXPECTATION :

An implicit definition of expectations is " attitudes, dispositions or psychological states of mind that relate to events the outcomes of which are uncertain" (Hashem: 1987). Expectations of future outcomes are commonly based on past experience but can also be formed without such hindsight. In the general sense, expectations are psychologically held subjective beliefs that may or may not be related to the individual's past experience or his present perception.

For Carter & Maddock (1984), " expectations are essentially forecasts of the future values of economic variables which are relevant to current decisions". For example, farmers have to forecast future prices and yields for various crops in order to determine at planting the crops which are likely to be most profitable. Households have to make implicit or explicit forecasts of future prices in deciding whether to purchase a new car, a washing machine or to do nothing. In particular, they have to forecast the opportunity cost of consumption, namely the appropriate market rate of interest.

Shackle's (1972; 1970) view of expectation is based on historical conceptualization of time, and rejects the logical time analysis that underlies the treatment of uncertainty in the statistical decision theory. According to Shackle, expectations are creative acts of imagination and fantasy, and do not lend themselves to formal representations by means of probabilistic models.

In this paper by expectation, we imply the decision maker's forecasts or predictions regarding the uncertain economic variables which are relevant to his or her decision. In other words, by an expectation we mean a specific size of gain or loss associated with a given degree of potential surprise or possibility.

In this regard Carter and Maddock (1984) distinguish two important characteristics of expectations:

a) They are essentially subjective and the personal judgement of a particular individual at a certain stage of his or her life. They do not have an independent existence apart from the person or decision-maker who holds them. They are based on the decision maker's personal strengths of belief about the occurrence of uncertain events and his personal evaluation of potential consequences.

b) An expectation regarding a particular economic variable need not be confined to a single predicted value. It is better regarded as a complete probability distribution over future values of the variable.

How expectations are formed and the way they influence economic behaviour, have become issues of central importance, both in the development of dynamic economic theory, and in econometric analysis of time-series data (Hashem: 1987). Despite considerable recent efforts (Singh: 1991; Calvo: 1988), the process by which economic expectations are actually formed is still not well comprehended. Earlier Arrow (1984), suggested that this is likely because studies of the influence of expectations on behaviour have methodological rather than substantive interest.

Theoretical expressions of expectations :

The importance of direct measures of expectations for the analysis of their effect on economic behaviour as well as for the study of the expectations formation process, has long been recognized in the literature (see Klein: 1954; Modigliani and Sauerlender: 1955; Haavelmo: 1958; Katona: 1958). An important source of direct measures of expectations is the public and professional opinion survey data which are now available for a wide range of variables in most industrialized countries. The most common theoretical ways used to express expectations are through statistical probability, expected utility and rational expectations as in the following elaboration.

1. Statistical probability :

An analogue of statistical probability, is the mathematical expectation of the value of a series of many repetitions of the operation. Cagan (1956), Nerlove (1956), Friedman (1957) and others, suggest that we make continuous adjustments in such a way that each expectation is compared with the reality when it is observed, and the expectation for the following period is obtained by revising the previous expectation in the direction of the actual figure. But we need a procedure quite different from that of averaging the things that have happened to others or to us in the past; we need a scheme which places in a strong light the worst and the best that can happen to ourselves through the decision-making process. In an economic context an individual may feel that the world is steadily changing and therefore, that any new observation is not simply one more made under circumstances identical to those in the past (Rotter 1954, pp.165-183).

Professor Shackle's (1972) theory of expectations and uncertainty is centred around the premise that the established theory founded on the application of the probability calculus to the choice of action-scheme under uncertainty, is inadequate, indeed is misdirected. According to him, decision making takes place in a world where time is real and where ignorance rather than knowledge abounds. Individuals in their endeavour to forecast the value of variables germane to their action-choice, are not confronted by a situation of risk. That is, they cannot rely on the relative frequencies of occurrence in the past of specified profit streams in order to make their own estimates.

It is time to appreciate the businessman's practical frame of thought. They are surely concerned, not with an average or amalgam of many mutually exclusive or contradictory ideas of the sequel to any action of their own, only one of which at most can in the event be approximately justified, but with estimating the worst danger or best conditions to which they proposed course of action seems to expose them. As there is no telling what will happen, it may be legitimate to form judgements of what can happen, at worst and at best.

2. Expected utility :

First postulated by Daniel Bernoulli over 200 years ago, but unrecognized until the work of Marshall in 1920 and of Von Neumann and Morgenstern (1944,1947) anticipated by Ramsey (1931). It is based on the supposition that an extra dollar is worth more to a poor man than to a rich man. Expected Utility and its corollary, the Expected Utility Theorem, have dominated the economics literature on choice under uncertainty during recent times (see Arrow: 1984 and Ford: 1987).The Expected Utility model is characterised by the simplicity and normative appeal of its axioms, the familiarity of the notions it employs (utility functions and mathematical expectation), the elegance of its characterisations of various types of behaviour in terms of properties of the utility function and the large number of results it has produced. It is thus not surprising that most current theoretical research in the economics of uncertainty, as well as virtually all applied work in the field, is undertaken in the expected utility framework (Machina: 1982,p 277-8).

In most economic models individual decision making depends upon the subjective perceptions about possible outcomes and their likelihoods. Estimates, judgement, inference, the exploitation of suggestions which the visible present and the records of the past supply, are the essence of the non-observable future. In this regard, the Expected Utility theorem simply says that individuals choose among alternatives in order to maximize expected utility (see Arrow, K. "Essays in the Theory of Risk-Bearing" Chicago: Markham Publishing Co., 1971). But the goals of farmers are multifaceted and economic utility does not necessarily explain the farmer's decision making process. The aspiration of individual farm ownership appears to dominate decision making; a matter perhaps more related to family security than to profitability. Thus, as is extensively discussed in Gasson et al. (1988), the issue of family security appears to dominate the profitability objective.

3. Rational Expectation Theory :

People seek to get the maximum utility, or by implication they maximize something from their scarce resources. In pursuit of that goal, forecasting errors will be as small as possible. The forecast that uses all of the relevant information available about past and present events and that has the least possible error, is called the Rational Expectation (Parkin: 1990). He defines Rational Expectation, as "the best forecast that can be made on the basis of all the available and relevant information". To make a rational expectation about future profit farmers form rational expectations about future prices and productivity based on their forecasts of future demand and supply, and likely environmental events. The possible price fluctuates around its rationally expected level. Higher-than-expected demand produces a higher-than-expected price. Higher-than-expected supply produces a lower than-expected price.

In the Rational Expectations approach, firms and households exhibit profit and utility maximizing behaviour. That is," firms and households employ all useful available information in maximizing profit and utility, given the cost of acquiring such information" (Hashem:1987). Some methods of forming expectations seem more rational than others, and at least formally one can treat the learning process itself as a process of successive choices by the individual. The domain of choice now is a strategy, that is, in each stage the individual finds the next step as a function of all the information available to the present time (Arrow: 1984). Despite important technical advances made over the past five years in the area of rational expectations models, there still remain important gaps with respect to the relation of dynamic multivariate models with future expectations.

II .- EXPECTATIONS IN FARM MANAGEMENT DECISIONS :

" Farm decision-making requires an evaluation of potential outcomes under various states of knowledge in conjunction with the goals of the manager and any conditions or assumptions he wishes to impose" (Harsh et al.: 1981). Since managerial goals are subject to change over the family/farm life cycle, individual farmers may not always make the same decision when confronted with the same problem.

Calkins and Di Pietre (1983) include in their definition, all the main components of Farm Business Management. According to them farm decision-making is "the attainment of farm family goals by using economic principles to formulate and implement budgets, adjusted for risk, and government programs that combine the factors of production within a suitable tax and business structure".To us, a decision seems to be a psychic act engendered by feelings about thoughts. There are no empirical measures of future outcomes. We can only be persuaded by subjective assessments. The thoughts involved in our context, are those which specify sizes of gain or loss and which associate degrees of possibility with these sizes. It will be a source of extra efficiency if the statement of degrees of possibility can be made in terms of feelings. Possibility is thus distinguished from probability by being an expression of intellectual and subjective perceptions, in the thought of the expectation former.

The manager of any business is faced with the problem of making decisions, but the manager of a farm makes decisions in a somewhat unique environment. Perhaps most important is the limitation placed on a manager's decisions by the biological and physical laws of nature (Kay: 1986). Farm managers soon find there are some things that cannot be changed by their decisions. Production on farms is perhaps affected as much by weather as production in any other type of business. On the other hand prices paid for resources and prices received for products sold, are determined by national and worldwide supply and demand factors, over which individuals farmers have very little control. Weather, insects and disease, which induce variable yields, are examples of environmental factors which place the farm manager in a position of making decisions in circumstances of peculiar risk and uncertainty. Future yields and prices cannot be predicted with accuracy, yet they are dominate management decisions. While there is a certain amount of risk and uncertainty in every business endeavour, the farm manager's decision-making environment contains more factors creating risk and uncertainty than most types of business.

Risk and uncertainty adds complexity to many problems and to the decision-making process. However, decisions must still be made, and the manager is faced with making the best decision given the uncertainty associated with the available information. Therefore, the manager must form an "expectation" about the product yield and output price for example, and somehow arrive an "expected" value to use in the decision-making process. The formation of expectations have crucial economic implications. For most corporate and policy decisions, some basic notion about future expectations and the factors that affect them, is a crucial input that decision makers need to know in advance (Singh: 1991). The past decade has witnessed important developments in the study of the expectations formation process and the problem of decision-making under uncertainty.

Forming Expectations in Farm Management Decisions :

The main task in the analysis of expectations is to evolve some scheme in which these three elements; formal, psychic and inferential, are satisfactorily fused. This scheme must in effect be able to rank or order the expectations, each taken as a whole, so as to show why the decision-maker chooses one course out of many possible ones. Schemes which have been proposed for this purpose differ radically in many respects. One question is how to express and represent the force of the claim of a particular expectation to be taken seriously.

Expectation must be provided with a language for expressing its uncertainty and its dual character of threat and promise, and this language must be such that a precise subjective comparison can be made, ex post facto, between the system of expectations and the recorded result, so as to indicate the response that will or should be made in future as we learn from experience.The possibility of modelling expectations depends on the nature of uncertainty that surrounds the decision-making process, the pervasiveness of customs and habits in the society, and the degree to which in regularities that exist are exploited by individuals. However, without direct measurement of expectations it will be difficult, if not impossible, to say whether an individual's expectations of a particular economic phenomenon can be modelled formally.

Before mentioning the possible ways that exists to measure expectation, we must introduce ourselves into the situation where the farmer has to make his own decisions. First, the farmer should perform some self-analysis concerning attitudes toward risk to make decisions which are compatible with personal preferences and goals and the financial conditions of the business. According to Kay (1986) there are two types of risk. *Business risk* involves any factor which affects the level of net farm income, such risks may be reduced by varying one's production decisions. *Financial risk* reflects the safety of the firm in a financial sense particularly as viewed by a potential lender. It is the main factor responsible for financial stress experienced by farm families. Major sources of risk are also perceived to include climatic, market and macroeconomic factors, however farmers do not believe that they have much ability to ameliorate the effects of these risks. Production responses appear the most likely strategies, with financial responses being considered less important. Despite these responses however, any reduction in farm risk seems to be of secondary importance compared to family goals.

Financial risk involves the proportion of debt and equity in the entire farm firm, and usually four financial ratios are used to measure it (Penson: 1987):

* debt/asset ;
* debt/liquidity ;
* current assets/current liabilities;
* Net Worth (equity)/ total assets.

But these ratios (as with other accounting ratios) have some limitations: they do not measure the effects on household consumption expenditure; they do not establish marginal utility changes, and finally they do not take account the individual's perception and expectations about future events. As Frengley & Johnston (1990) explained " a low present income with poor future prospects must undoubtedly be more stressful than if future prospects are bright". Financial ratios can adequately measure the effect of financial changes on the farm business, but they can easily fail to represent the feelings and beliefs of the farm family.

Forming expectations in the decision-making process :

Several methods can be used to form an expectation about future prices, yields, land and other values which are not known with certainty. Once an expected value is obtained it can be used for planning and decision making, as it becomes the "best estimate" of some unknown value which only be determined by future events. Most of the literature refers to expectations using averages, most likely, and other mathematical expressions, that have the limitations discussed before. When we speak about financial stress we must look further.

Financial stress measures have to express both the change in marginal utility, and the individuals' expectations about future events. It is this characteristics which distinguishes the purely financial measures from those which involve utility (Frengley and Johnston: 1990). As Marshall in 1920 (p. 100) said " a prudent person will endeavour to distribute his means between all their several uses, present and future, in such way that they will have in each the same marginal utility".

Financial stress experienced by farm families, and so the expectation about future events, directly influences agricultural supply response, through the influence on farmer's input and investment decisions. There are important lessons when regarding a farm as a family business, according with Gasson et al. (1988). This topic has been under-explored and it represents a valuable arena for further research on policy-related issues (see Errington: 1986). A considerable body of literature questions whether the firm's objective is indeed to maximise profit in the short or long run (see for instance Nettl: 1957 and McGuire: 1964). Profit maximization may not be the only or even the prime objective, it can be others like power, control, prestige, etc., (Hay and Morris: 1984). And in addition to farmers' objectives, the influence of other factors placing constraints on possible courses of action is important to an understanding of the behaviour of the farm family firm and its real objectives (Newman et al.: 1991). Furthermore, when considering the farm as family business, it would be interesting to discover whether the objective function changes with stage of the family development cycle (we will see this later with the case study).Then, in the analysis of the financial stress experienced by farm families and their expectations about future events, we must consider a measure that takes in account their objectives as well as all the other factors that can influence their decision-making process.

A proposed measure of expectation :

In this paper we will examine **" the adjusted consumption stress ratio"** proposed by Frengley and Johnston (1992) to account for changes in income and consumption expectations:

$$\text{Adjusted Consumption Stress Ratio} = \frac{\text{Total interest payments}}{\text{Total household consumption}}$$

Total household consumption is calculated by adding transfers of funds, into or out of farm equity or capital reserves, to net household consumption derived from the firm's current net profit. In the unadjusted version of the Consumption Stress ratio, expectations about future events are ignored, as the measure of net household consumption does not include transfers of funds to and from reserves.

According to Anonymous (1990), consumption will be buoyed by the rise in disposable income resulting both from pay increases and from the growth of income on financial saving, induced by high interest rates. According to Fisher (1954), " the rates of interest are always based upon expectation, however little this hope may later be justified by realization" and "our present behaviour can only be affected by the expected future, not the future as it will turn out but the future as it appears to us beforehand through the veil of the unknown ".

Uncertainty of human life increases the rate of preference for present over future income for many people (see Carver: 1904, p: 256), although for those with loved dependents it may decrease impatience. Man makes his guess of the future and stakes his action upon it. Then, if a man regards the income for the next few years as sure, but is in doubt as to its continuance into the more remote future, he will be more keenly alive to the needs of that future, and will consequently have a less keen preference for the present. He will then be willing to invest out of his present assured income, to his uncertain future income. The adjusted consumption stress ratio expresses this choice that each farmer has, to consume now or in the future (Johnston and Frengley: 1991). It balances the effect of decisions on present consumption (denominator), and the influence of this on expected future consumption, through interest costs (numerator).

The case study :

To illustrate the discussion above, we will apply the Adjusted Consumption Stress Ratio to a case study, a sheep and beef S.I. High Country farm. The results of 18 years period (1972-1990) will be compared to what had happened in the same period to the rest of the same class farms (S.I. High Country - No 1 NZMWBES), and to the opposite one, the class that differs most (S.I. Intensive Finishing - No 7 NZMWBES), as well as to the average of New Zealand sheep and beef farms (All Classes - NZMWBES).

A Trend Analysis:

The history of this farm family is the same as many other sheep and beef producing farmers from around the world. They, as with most of us, have several stages during their life; first we are prepared to work prolonged hours to increase our earnings. We effectively reduce our leisure time to assure our future consumption; later we are balanced, seeing no need to provide for the future; and finally we reduce our work load as our ability to work declines. Our life pattern is of work/saving, consumption and leisure conforms pragmatically with Marshal's hypothesis of equimarginal temporal utility (Marshal: 1920,100). The length of each of these stages depends more on factors beyond the farm gate which will affect directly the success of the business, than from factors inside the farm.

Research and real life experience shows that it is the vision individuals create for their future that determines what that future will be, more than any other element. To envision your future, to establish your lifetime purpose and then to deliberately take the steps toward that vision, is a powerful act of creativity and courage. Planning means little, especially in hard times, unless the goals are very clear and the attitude is positive. Negativism perpetuates self defeat.

The present owner commenced farming in 1972 when he bought the farm from his father. At that time he had almost no capital (Figure 1), so he had to borrow. At that time his long run expectation about the future of the business had been good or at least sufficiently acceptable to be a dominant reason why he got into the farming business.

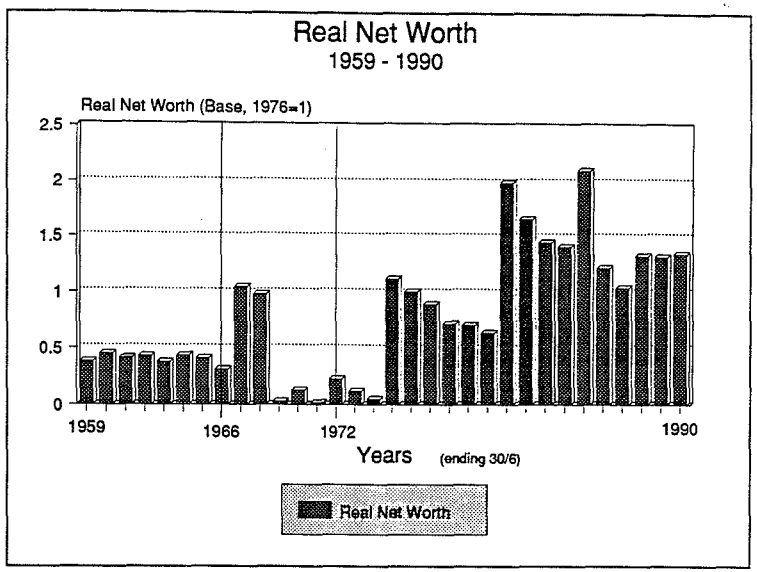

Figure 1 .- Real Net Worth for the Case Study Farm, 1972-1990 (Base, 1976=1)

He and his wife as with many other young farm couples, decided together to take the risk of commencing farming with minimal capital. They might have thought then that their only capital was their capacity to work, so they decided to minimize their leisure in order to be able to work more. They constrained their consumption, reducing this to the indispensable. At that time we can premise that their expectation about their future in the short and medium run, should have been bad because of the size of the financial obligations they had taken. They agreed to stress themselves financially to be able to pay their debts, and during the first 5 years they suffered, shown by a high consumption stress ratio (Figure 2), significantly higher than all the others farms considered (Figure 4). As a result of their effort and sacrifices, they were not only able to pay their debt obligations on time, they were also able to save and capitalize on their effort in real terms more effectively than all other farm classes considered in this analysis (Figure 1). The difference between the adjusted and unadjusted consumption stress ratio from Figure 2, refers to the inclusion of saving/disaving (saving in this case) in the adjusted ratio.

In 1976 their financial stress peaked then commenced falling (Figure 2). A variety of factors accounted for the improvement. A lower interest expense in relation to a continuous increase of the Gross Farm Income (Figure 3); an increase in total stock units carried in the farm with a lower sheep/cattle ratio; fixed total liabilities with a continuous increase in Net Worth (Figure 3); the adoption of lower-cost farm management systems; and an increase of capital invested off the farm, are some of the factors which gave the farm more flexibility to better cope the variability of the market prices and other imponderables, weather, disease problems, etc. As a result, they started feeling financially stronger and on the way to reach their goals.

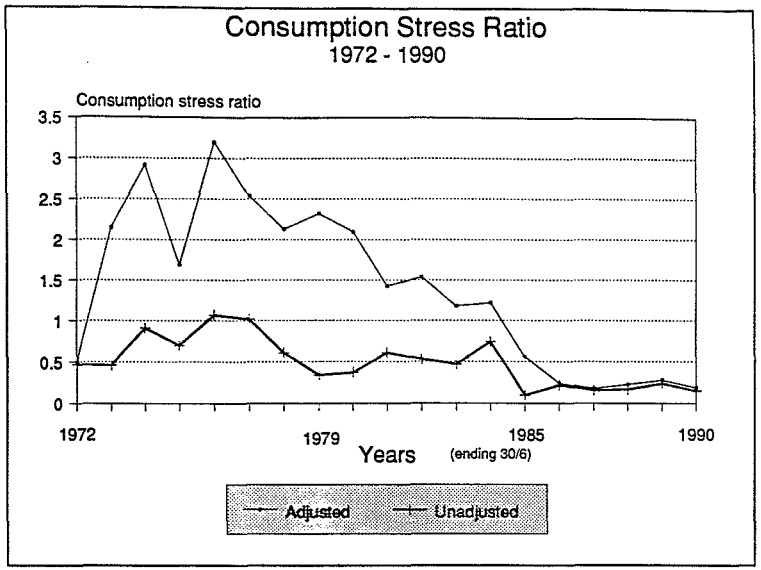

Figure 2. Adjusted and Unadjusted Consumption Stress ratio for the case study (1972-1990).

Their expectation about the short and medium run began to change, they were more optimistic, and decided to increase their household consumption. Their equity continually grew till 1981 when it seems likely to have reached a satisfactory level according to this particular family's goals (Figures 1 and 4). Their interest expense in dollars has remained constant since then, but as a percentage of Gross Farm Income it has been continually declining (Figure 3). As a result their expectation of the future kept on improving. Each year they felt more secure, more confident about their future, and slowly increased their household consumption resulting in a continued fall in the consumption stress ratio (Figure 2). In 1985 their household consumption stress ratio stopped falling, and their financial stress has since then been lower than the average of the farm classes considered in this analysis (Figure 4).

In 1986 they reached an equilibrium in the balance between leisure and work, saving and disaving. They felt they had enough capital to support themselves, they did not need to borrow or to save more money. On the other hand their obligations to the children's education became on important priority (Figure 2). As a consequence of this since 1984 their household consumption increased rapidly till 1986 and the consumption stress ratio fell abruptly (Figure 4). But since 1986 it has been very stable and low, lower than the average of the farm groups considered here. Their current future expectation is soundly based on solid financial solvency. Their need to increase their leisure in relation to work to improve overall utility is apparent.

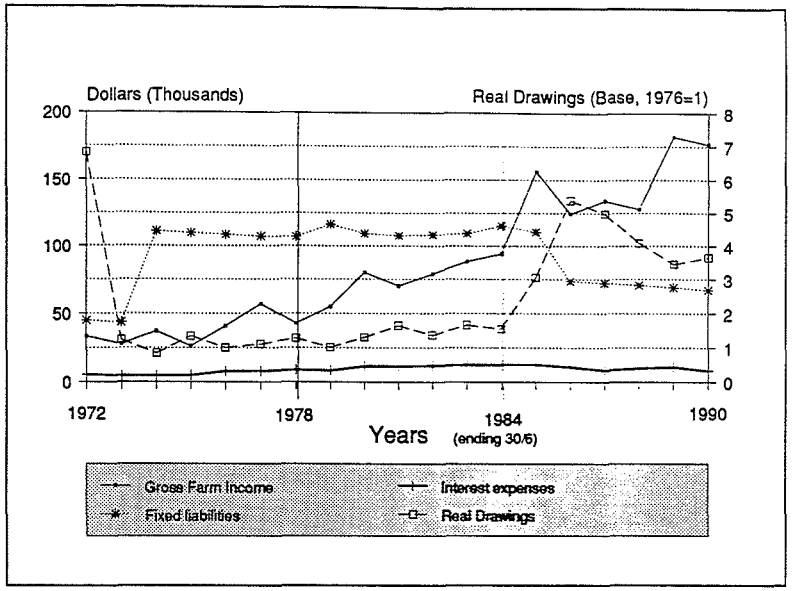

Figure 3. The Case Study: Nominal Interest Expenses, Gross Farm Income and Fixed Liabilities and Real Adjusted Consumption (1972-1990).

It is time for them to start having more leisure and less work. Their acceptance of a reduction in their Real Net Worth without any variation in the consumption stress ratio confirms this observation (Figures 1 and 2).

The Consumption Stress Ratio has accurately expressed in this example, how the feelings and expectations of this farm family about their future, have varied through the 18 years according to their life-stage, and the farm family's success in achieving its goals.

Cross-section analysis:

When considering class averages, less variability in the consumption stress ratio is expected. Averages include several farm families living in different stages of their lives, with different priorities and needs. If we wish to compare this particular farm with any class, we have to be cautious.

Changes in the household consumption stress ratio reflect changes in household stress, and as market environment, risk, interest cost of debt, and investment/disinvestment were the same for all the farms considered here, we can make comparisons between these farm classes. All were equally exposed to these external events. But again, we have to be aware of the limitations when using averages. These averages are the financial results of 15 years of assistance policies prior to deregulation in 1985. We will divide this period in three: first, the principal interventionist policies period that commenced in the early 1970s with extended cost subsidies; then the commodity price support which began in 1979, and finally since 1985 the deregulated environment.

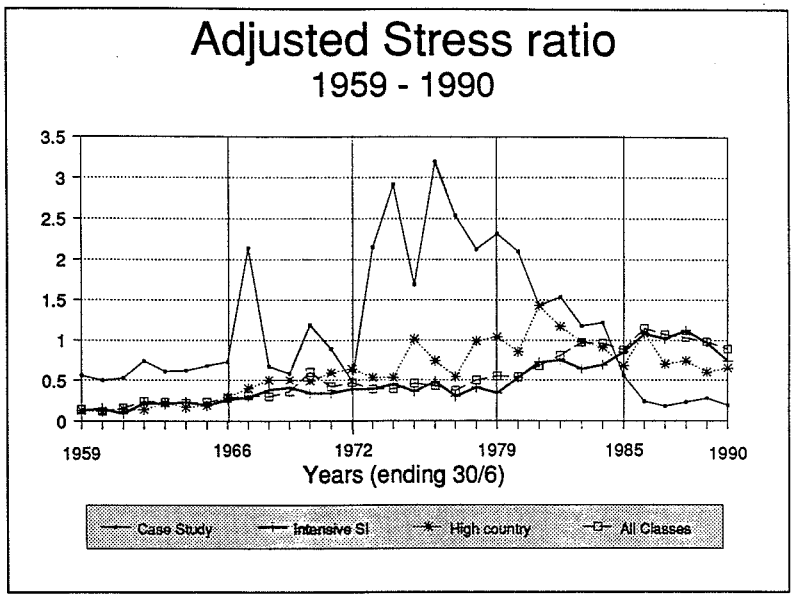

Figure 4. Adjusted Consumption Stress ratio (1972-1990)

In the 70s the stress suffered by the average of all sheep and beef farms (All Classes NZMWBES) and SI Intensive (No 7 NZMWBES) was low and stable, with comparatively constant interest rates and opportunities for farmers to save funds. Their only concern was how to increase production. But with declining wool prices the High Country class became increasingly stressed within this period, although it was not as great as the case study at the same time. This was partially explained by its high interest expenses (in comparison with the other two classes), reducing cash surpluses and constraining household expenditure.When the commodity price support began in 1979, the household consumption stress experienced for all sheep and beef farm classes outlined rose progressively; their interest expenses began to increase rapidly as they borrowed to increase inputs and production; their real drawings and Net Worth started falling (Figure 5). One of the reasons which explained the reduced stress of the case study farm during the financial difficulties since deregulation (1985) for the majority of New Zealand sheep and beef farms, was its good control of interest expenditure and fixed liabilities by then. When on average almost all classes were increasing their debt, they were reducing theirs to its lowest limit (their outstanding debt is a fixed interest family loan supporting the lender's consumption)(Figure 3).

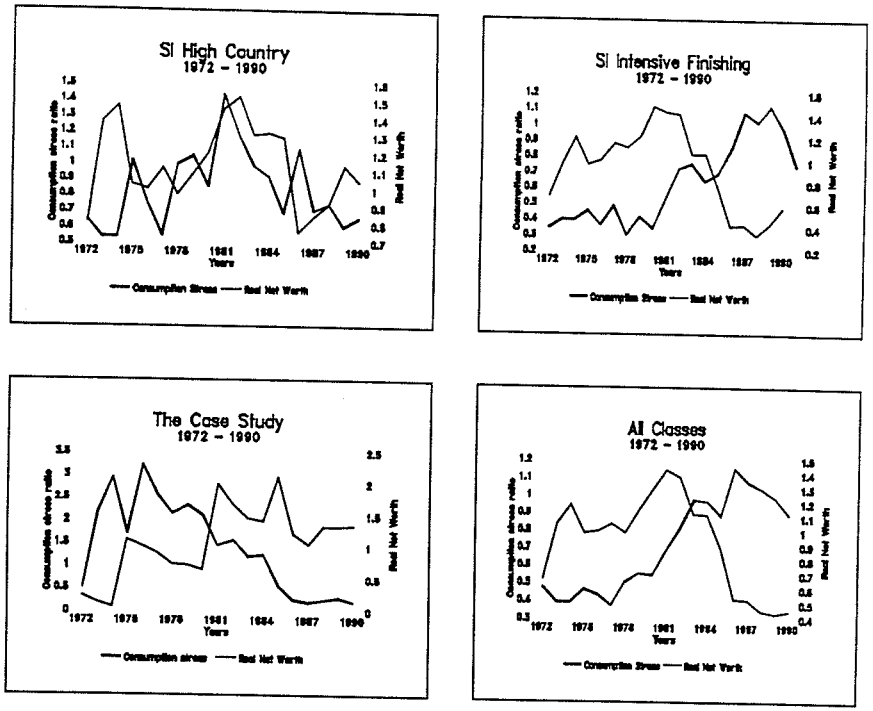

Figure 5. Consumption Stress Ratio and Real Net worth Relationship (1972-1990) (Real Net Worth base, 1976=1)

As the High Country class had a relatively higher interest expense, their stress increased at a greater rate than the rest of the classes. But as they suffered more before the introduction of commodity price support, they adopted solutions to the problem of excess debt before the other classes, even before the start of the deregulation process. As a consequence, they started reducing their household consumption stress in 1983, before deregulation. This period (1979-1984) was the worst of the three. During this time almost all sheep and beef New Zealand farms reduced their Real Net Worth (Figure 1), the greater their debt/equity ratio the greater their percentage of equity loss.

At the beginning of the deregulation process (1985) most of New Zealand sheep and beef farms were suffering from financial stress. 1986 was the most stressful year. According to Frengley and Johnston (1992) approximately two third of all sheep and beef farm household consumption expenditure was derived from reserves in that year. Deregulation stopped the decline in their equity, and since it has been implemented sheep and beef farms' equity has been low but stable. After the stressful peak of 1986 their Real Net Worth slowly recovered; first was the High Country Class in 1986, then the case study in 1987 and the SI Intensive Finishing class in 1988.

In the last two years (1988/89;1989/90) the household consumption stress of sheep and beef farms has been falling. Current levels are now as low as at the beginning of the 70s. As with the average of High Country farms, the case study has since 1987 had a very low and stable Consumption Stress ratio. Apart from being stronger from a solvency view point than the comparable farm classes, the case study reduced its interest as a percentage of Gross Farm Income before the retreat from price support (Figure 6), and it was better prepared in 1985 to face the new environment created by the deregulation process. SI Intensive Finishing and All Classes farms depended more on borrowed money (a higher interest expense as a percentage of Gross Farm Income, Figure 6), and were forced to adapt their systems to the new situation, or wait till the interest rate and inflation fell, as finally happened in 1991.

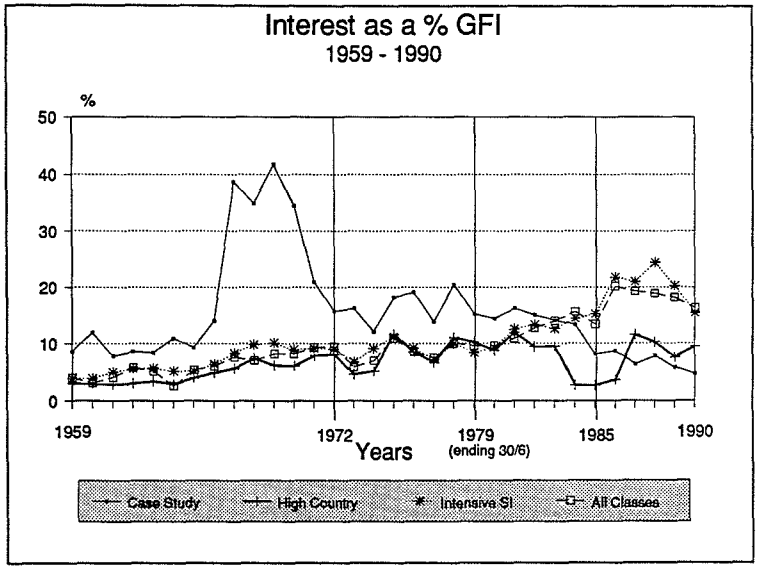

Figure 6. Interest as a percentage of Gross Farm Income.

According to the falling current household consumption stress, we can conclude that the expectation about the future of the farms considered here, and particularly of the case study and the High Country class, is becoming optimistic. These farm families now expect a general recovery, with prospects of equity growth.

CONCLUSIONS:

The Consumption Stress Ratio used in the analysis within and between farms, provides insight to farm families' expectations in a variety of financial circumstances, and may assist in the formation of farm policies. As we saw in this paper, high consumption stress situations may predicate recoveries in real equity.

We conclude this paper with the observation that good management consists of more than decision-making based on economic expectations. It includes strategies to adapt to a variety of circumstances and lifetime family objectives, of which economic objectives and responses are merely a part.

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RISK ANALYSIS AND FARM MONITORING

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ABSTRACT

The farm monitoring process, to date, has relied on single point estimates for all key budget parameters. Forecasting, however, involves significant elements of risk. A computer simulation program, called the stochastic budgeting model has been developed to account for such risk. A trial was conducted using one of the farm monitoring regional submodels over 1991/92. A measure of risk is the standard deviation of budget outcomes. Farmer perceptions of risk showed a declining trend over the year as actual values of key parameters became known. There was an increase in risk between the forecasts made for September and December and these were largely due to lamb price expectations. There are differences in the results obtained through the normal farm monitoring approach and that of SBM. This is due to skewness in the distributions of key parameters; the most likely values can differ from the mean values. The differences in gross farm income and cash farm surplus are very minor but more significant for net cash surplus. Feedback from the farmers involved was favourable as they were more comfortable forecasting a range rather than a single point value.

INTRODUCTION

MAF Policy has a responsibility to monitor the performance of the agriculture sector. Part of this involes the farm monitoring system which is a mechanism of advising Government on farmer (agricultural) and grower (horticultural) views of their short-term financial outlook and business intentions (Morriss 1990).

Farm monitoring is carried out by describing representative or typical models for a number of regionally based farm classes. In developing each model, consultants draw on a number of actual farms. Farmers are interviewed for their expectations of budget inputs and outputs for the financial year ending in June. The regional models are aggregated up to class representative models and then to a national representative model, for example, the All Classes Representative Sheep and Beef Farm. This is carried out in May and October with Farm Monitoring Reports published in June and December.

For 1992/93, there are 24 sheep and beef models with 273 farms monitored and representing 17,540 farms; eight dairy models with 101 farms monitored and representing 13,325 farms; one deer model with 12 farms monitored and representing 2,500 farms; three pipfruit models with 25 orchards monitored and representing 795 orchards; and one kiwifruit model with 16 orchards monitored and representing 1,400 orchards (John Squire pers comm). Bona fide farms are defined as having sufficient gross income that after meeting normal farm working expenses and in a debt free situation would leave, for a two parent/two children family, a minimum living wage of $12,000 (according to the Department of Social Welfare).

Acknowledgements are made to Steward Finlayson, Jeremy Neild, Grant Porter and Arthur Watson of MAF Management Consultancy Services and to the nine farmers contributing to the Wanganui/ Rangitikei Hill Country Class 4 farm monitoring model.

The views expressed in this paper are those of the author and not necessarily those of MAF Policy.

MAF Policy has developed a stochastic budgeting model (SBM) that enables an annual farm budget to be simulated from input data that is specified in terms of three point estimates; a most likely (modal) with optimistic (high) and pessimistic (low) bounds (Jarvis *et al* 1989 and Forbes and Harvey 1990). Where only a single point estimate is entered, the variable is deterministic. To date, farm monitoring has always used a deterministic approach. The model handles a combination of sheep, cattle and cropping enterprises. A separate model replaces the sheep for a dairy module.

In developing a forecast budget, there is uncertainty present regarding the level of performance parameters (eg lambing percent and wool weight), product prices (eg store two tooth ewes and rising three year steers), and macroeconomic parameters such as interest rates and exchange rates for the budget period. Risk and uncertainty have separately defined meanings, however in current practice, the distinction has become less important.

In a purely objective sense, risk refers to variability of outcomes that can be statistically measured, while uncertainty refers to variability of outcomes that are totally immeasurable. Most items of variability would be a combination of both risk and uncertainty, and simply referred to as risk. What makes this possible is the acceptance of a combination of both objective and subjective distributions regarding variable outcomes. Subjectivity is an individual's value judgement or perception regarding risk.

The degree of risk can be explained in terms of the variance associated with a range of possible outcomes; the wider the range (higher the variance) between the lowest and highest value for a particular variable, the greater the risk. Conversely, the narrower the range (lower the variance), the smaller the risk. The statistic commonly used to explain risk is the standard deviation, which is the square root of the variance. For multiple variables, the coefficient of variation - a scale neutral measure - enables better comparisons of variability between variables.

SBM assumes a triangular distribution for all stochastic inputs and simulated outputs from the model. The shape of the distribution influences the mean. Distributions can be skewed by the position that the most likely value has in relation to the mid point between the two extremes. Where the most likely value is closer to the lower end, a negative skew occurs and the mean exceeds the most likely value. Conversely, a positive skew ensures that the most likely exceeds the mean value. Thus the simulated mean budget outcome, say net cash surplus, may well differ from that of the most likely budget outcome.

In combining a number of stochastic inputs, cognisance must be made about the relationship between them, that is, the cross-correlation coefficients must be specified. These are derived from statistical analysis and interpretation. Correlation coefficients vary from minus one to plus one and influence the size of the standard deviation of simulated outputs. In general, the closer the correlations are to zero values or independence, the higher the output standard deviations.

Farmers operate in an environment of business and financial risk and in making budget forecasts, attempts can be made to evaluate such risk. In developing regional farm budget models in the farm monitoring process, farm consultants account for district trends and draw on a small number of actual farms. Farmers are interviewed for their expectations as at June (beginning), December (mid point) and June (end) of the financial year. As the year progresses, the level of uncertainty pertaining to key budget variables declines to certainty and this would be reflected in a narrowing of the output distributions and a reduction in the standard deviations, if elicited data includes a range about the most likely value of key variables.

A trial was undertaken in the 1991/92 year for one sub-regional model; the Wanganui-Rangitikei hill country model. This involved gathering expectations from nine farmers and compiling them into a representative model for the district. The trial began in the September round of farm monitoring because of delays in the development and validation of SBM. In a departure from normal farm monitoring procedures, farmer expectations were also elicited for the March round. Thus data was obtained for the September round and then revised for the subsequent December, March and June rounds.

We limited the stochastic variables to 15. Three performance variables of lambing percent (survival to sale), calving percent (survival to sale) and wool (kg/su); eleven revenue variables of wool ($/kg),ewe lamb ($/hd), wether lamb ($/hd), wethers ($/hd), two-tooth ewe ($/hd), mixed age ewe ($/hd), rising two year heifer ($/hd), rising three year heifer ($/hd), mixed age cow ($/hd), rising two year steers ($/hd) and rising three year steers ($/hd); and bank base interest rate. The revenue variables are predominately farm gate prices, that is, net of transport and marketing costs, and relevant levies.

To aggregate the farmer expectation data to a representative model, the procedure was as follows:

1 data from the farms was averaged at the pessimistic, most likely and optimistic levels to derive three farm group values;

2 the single, most likely value used in farm monitoring was taken as the most likely for SBM, and the two extreme values adjusted by the ratio of farm monitoring to farm group most likely values.

As an illustration of the aggregation procedure, the forecast data on lambing percent for the September run is set out in table 1.

Annual drawings were set at a minimum of $12,000 and a maximum of $18,000 as at September, December and March with an increase to $19,000 in June. The actual amount over the minimum, is dependent on the net cash surplus available (30% being allocated to additional drawings).

Table 1: Forecasted lambing percent (survival to sale) for the September round

Farmer #	Low	Modal	High	Skew
1	102	110	116	+ve
2	94	95	100	-ve
3	90	95	105	-ve
4	95	100	110	-ve
5	90	90	93	-ve
6	90	95	100	nil
7	105	105	115	-ve
8	85	88	95	-ve
9	105	120	125	+ve
Average	95	100	107	-ve
Monitoring		95		
SBM	90	95	102	-ve

Note:

Low = pessimistic
modal = most likely
high = optimistic

Skew:

-ve negative, the modal closer to the low
+ve positive, the modal closer to the high
nil modal in central to low and high

Four variables are selected to show how aggregated farmer expectations changed over the course of the year; lambing percent, and the farmgate returns for wether lamb, wool and rising three year steers. Table 2 sets out the data.

Table 2: Change in expectations for lambing percent, and wether lamb, wool and R3 year steer prices in the September, December, March and June rounds of farm monitoring.

	September	December	March	June
Lambing %				
Low	90	89	89	-
Modal	95	94	94	94
High	102	97	94	-
Skew	-ve	+ve	+ve	-
Wether Lamb $/hd				
Low	16.1	14.0	22.0	27.0
Modal	20.5	18.5	25.0	27.6
High	23.6	23.6	27.0	28.6
Skew	+ve	-ve	+ve	-ve
Wool $/kg				
Low	2.60	2.43	2.36	2.48
Modal	2.78	2.60	2.44	2.50
High	3.12	3.00	2.52	2.52
Skew	-ve	-ve	nil	nil
R3 year steer $/hd				
Low	692	692	775	-
Modal	760	760	800	780
High	820	820	860	-
Skew	+ve	+ve	-ve	-

Note:

Skew: -ve negative, the modal closer to the low
+ve positive, the modal closer to the high
nil modal in central to low and high

For lambing percent (survival to sale), the low and modal forecasts were quite stable but the high retreated progressively. The skewness showing the September upside expectation of the mean reversing from December to a downside expectation. In September docking is not completed so the lamb drop is not known, by the December round the late lambers are an unknown contribution so again a reasonably large range in values is present. In March the upper limit is set by the number of lambs on the farm, but as these are hill country properties with few lambs sold by then, there is still a risk of losses that could reduce the number of lambs available for sale.

For wether lamb, price expectations fluctuated quite strongly over the period with the modal value moving first down from September to December and then up for March and June. The lift in expectations from September to June were quite substantial. The skewness showing downside expectations of the mean in September and March, and the reverse in December and June. At the time the December round estimates were being made, the lamb trade looked particularly bleak. By March the lamb schedule had risen considerably, farmers knew how their lambs were growing and had a fairly good idea of the price likely to be received, and hence the relatively narrow range of values.

For wool price, expectations showed a steady downward trend for low modal and high values. The skewness showing an upside expectation of the mean for September and December, and a converging with the modal value in March and June. Most of these farmers would have sold the majority of their wool in the December/January period. With the relatively small amount of wool to be sold after the March round, this would not affect the overall price to be used in the budgets even though prices had improved late in the season.

For rising three year steer, price expectations remained unchanged for September and December, increasing for March with a final deterministic outcome midway between the modal estimates for December and March. The skewness showing an upside expectation of the mean for September and December, and a downside expectation for March. Actual sales occurred in May/June.

Table 3 sets out statistics, on a per stock unit basis, derived from SBM for the sales of sheep, cattle and wool, and after tax profit for September, December, March and June.

Table 3: Selected SBM output statistics for September, December, March and June

	September	December	March	June
Sheep sales			*$/sheep su*	
Minimum	10.24	8.89	13.78	16.46
Maximum	15.47	14.54	15.78	17.09
5%	10.64	9.96	13.97	16.52
95%	14.81	13.77	15.55	16.97
Mean	12.85	11.71	14.78	16.73
SD	1.18	1.23	0.46	0.15
CV	0.09	0.10	0.03	0.01
Cattle sales			*$/cattle su*	
Minimum	30.28	30.59	35.65	35.38
Maximum	35.86	35.69	38.86	35.53
5%	30.81	31.25	36.07	35.39
95%	34.81	34.57	38.39	35.49
Mean	32.97	33.02	37.08	35.45
SD	1.24	1.20	0.71	0.03
CV	0.04	0.05	0.02	0.00
Wool sales			*$/total su*	
Minimum	14.07	13.03	12.72	13.58
Maximum	17.43	16.42	14.07	13.94
5%	14.62	13.74	13.02	13.65
95%	16.93	15.92	13.61	13.83
Mean	15.68	14.79	13.38	13.74
SD	0.70	0.74	0.26	0.07
CV	0.04	0.05	0.02	0.01
After Tax Profit			*$/total su*	
Minimum	-7.09	-7.41	0.76	3.49
Maximum	19.70	17.21	15.18	14.11
5%	-4.57	-2.60	2.38	5.11
95%	17.29	14.04	12.86	11.71
Mean	6.03	5.17	7.10	8.28
SD	6.13	5.82	3.14	2.44
CV	1.02	1.12	0.44	0.30

Note:

Minimum: the lowest possible simulation outcome.
Maximum: the highest possible simulation outcome.
5%: average of the 9th, 10th and 11th simulation runs ranked by net cash surplus. Thus a 5% interval of 200 simulations.
95%: average of the 189th, 190th and 191st simulation runs ranked by net cash surplus. Thus a 95% interval of 200 simulations.
SD: the standard deviation.
CV: the coefficient of variation - SD divided by the mean

The mean outcome of sheep sales per sheep su for September was $12.85. This reduced to $11.71 for December, increased to $14.78 for March and then increased to $16.73 for June. The main influence being lamb value (price and weight). The standard deviation for September was $1.18. This rose slightly to $1.23 for December and then fell to $0.46 and $0.15 for March and June, respectively.

The mean outcome of cattle sales per cattle su for September was $32.97. This rose slightly to $33.02 for December, increased to $37.08 for March and then declined to $35.45 for June. The standard deviation for September was $1.24. This declined slightly to $1.2 for December and then fell to $0.71 and $0.03 for March and June, respectively.

The mean outcome of wool sales per sheep su for September was $15.66. This declined to $14.79 and $13.38 for December and March, respectively, and then rose slightly to $13.74 in June. The standard deviation for September was $0.7. This rose slightly to $0.74 for December and then declined to $0.26 and $0.07 for March and June, respectively.

Sheep, cattle and wool sales form about 95% of gross income. Comparative variability of these sales categories can be assessed from the coefficients of variation (CV). Cattle and wool have values that are low and similar for the period of study. Sheep values are substantially higher than those of cattle and wool, for the September and December rounds. Thus perceived risks are greater for the factors making up sheep sales than for the other two categories, in these two periods. For March, the CVs for sheep, cattle and wool sales are similar, as are those for June.

The mean outcome for after tax profit per total su for September was $5.94. This declined to $5.08 for December and then rose to $7.03 and $8.21 for March and June, respectively. The standard deviation for September was $6.14. This declined to $5.83 for December and then declined to $3.14 and $2.44 for March and June, respectively. The sequence of the CVs was 1.03, 1.15, 0.45 and 0.3 for September, December, March and June, respectively, thus mirroring that of the sheep sales category.

Table 4 sets out the September budget outcomes in terms of the five percent interval, the mean, the 95 percent interval and the most likely. Tables 5, 6 and 7 set out similar data for December, March and June. For after tax profit and change to equity, the differences are highly influenced by livestock value changes.

There are some slight differences between the mean and most likely outcomes. The differences for gross farm income (GFI), cash farm surplus (CFS) and net cash surplus (NCS) indicate positive skews for September and March and negative skews for December and June. For GFI and CFS, the differences from the mean, in absolute terms, are all less than 1% and 1.5%, respectively. For NCS, the differences from the mean, in absolute terms, are 1507%, 17%, 16.5% and 1.8% for September, December, March and June, respectively.

Table 4: SBM farm budget outcomes for September

	5% Interval	Mean	95% Interval	Most likely
Sales				
- Sheep	30,981	37,418	43,116	38,134
- Cattle	25,279	27,048	28,779	27,050
- Wool	42,543	45,607	49,606	45,334
- Crops	0	0	0	0
Other Income	*4,650*	*4,650*	*4,650*	*4,650*
Purchases				
- Sheep	-1,200	-1,200	-1,200	-1,200
- Cattle	-1,800	-1,800	-1,800	-1,800
Gross Farm Income	*100,453*	*111,723*	*123,151*	*112,168*
Working Farm Expenses	-63,481	-63,491	-63,491	-63,486
- Discr. Component	0	0	0	0
Cash Farm Surplus	*36,972*	*48,232*	*59,660*	*48,682*
Interest Paid	-18,172	-18,055	-18,257	-18,175
Taxation	-3,417	-7,078	-11,319	-6,854
Mtg/Loan Repayments	-8,518	-8,518	-8,518	-8,518
Debt Retirement	0	0	0	0
Drawings	-12,000	-12,426	-13,909	-12,000
Development Exp	0	0	0	0
Capital Purchases	-3,200	-3,200	-3,200	-3,200
Net Cash Surplus	*-8,335*	*-1,065*	*4,457*	*-65*
Profit Calculation				
Cash Farm Surplus	36,972	48,232	59,660	48,682
Interest + Tax	-21,589	-25,133	-29,577	-25,029
Livestock value change	-29,440	2,394	37,433	1,553
Depreciation	-3,000	-3,000	-3,000	-3,000
Deferred Interest	0	0	0	0
Reval. Loans & CA	0	0	0	0
After Tax Profit	*-17,057*	*-22,493*	*64,516*	*22,206*
Drawings	-12,000	-12,426	-13,909	-12,000
Loans written off	0	0	0	0
Change to Equity	*-29,057*	*10,067*	*50,607*	*10,206*

Note:

5% interval: *A 5% interval of 200 simulations expressed as the average of the 9th, 10th and 11th runs ranked by net cash surplus.*

95% interval: *A 95% interval of 200 simulations expressed as the average of the 189th, 190th and 191st runs ranked by net cash surplus.*

Table 5: SBM farm budget outcomes for December

	5% Interval	Mean	95% Interval	Most likely
Sales				
- Sheep	29,018	34,104	40,084	34,664
- Cattle	25,640	27,090	28,362	27,100
- Wool	40,007	43,062	46,360	42,399
- Crops	0	0	0	0
Other Income	*-7,150*	*7,150*	*7,150*	*7,150*
Purchases				
- Sheep	-1,200	-1,200	-1,200	-1,200
- Cattle	-1,800	-1,800	-1,800	-1,800
Gross Farm Income	*98,815*	*108,406*	*118,956*	*108,313*
Working Farm Expenses	-63,053	-63,060	-63,066	-63,064
- Discr. Component	0	0	0	0
Cash Farm Surplus	*35,762*	*45,346*	*55,890*	*45,249*
Interest Paid	-18,313	-17,786	-17,355	-18,019
Taxation	-3,177	-6,143	-9,685	-5,927
Mtg/Loan Repayments	-8,518	-8,518	-8,518	-8,518
Debt Retirement	0	0	0	0
Drawings	-12,000	-12,389	-13,779	-12,000
Development Exp	0	0	0	0
Capital Purchases	-2,400	-2,400	-2,400	-2,400
Net Cash Surplus	*-8,646*	*-1,890*	*4,153*	*-1,615*
Profit Calculation				
Cash Farm Surplus	35,762	45,346	55,890	45,249
Interest + Tax	-21,490	-23,929	-27,040	-23,946
Livestock value change	-20,969	877	26,559	588
Depreciation	-3,000	-3,000	-3,000	-3,000
Deferred Interest	0	0	0	0
Reval. Loans & CA	0	0	0	0
After Tax Profit	-9,697	19,294	52,409	18,891
Drawings	-12,000	-12,389	-13,779	-12,000
Loans written off	0	0	0	0
Change to Equity	-21,697	6,905	38,630	6,891

Note:

5% interval: *A 5% interval of 200 simulations expressed as the average of the 9th, 10th, 11th simulation runs ranked by net cash surplus.*

95% interval: *A 95% interval of 200 simulations expressed as the average of the 189th, 190th 191st simulation runs ranked by net cash surplus.*

Table 6: SBM farm budget outcomes for March

	5% Interval	Mean	95% Interval	Most likely
Sales				
- Sheep	40,668	43,027	45,286	43,753
- Cattle	29,597	30,428	31,497	30,390
- Wool	37,917	38,961	39,644	39,079
- Crops	0	0	0	0
Other Income	7,150	7,150	7,150	7,150
Purchases				
- Sheep	-1,200	-1,200	-1,200	-1,200
- Cattle	-1,800	-1,800	-1,800	-1,800
Gross Farm Income	*112,332*	*116,566*	*120,577*	*117,372*
$Working Farm Expenses	-64,159	-64,159	-64,159	-64,161
- Discr. Component	0	0	0	0
Cash Farm Surplus	*48,173*	*52,407*	*56,418*	*53,211*
Interest Paid	-17,159	-16,950	-16,803	-16,772
Taxation	-6,708	-8,129	-9,623	-8,411
Mtg/Loan Repayments	-8,757	-8,757	-8,757	-8,757
Debt Retirement	0	-0	0	0
Drawings	-12,164	-13,073	-13,870	-13,281
Development Exp	0	0	0	0
Capital Purchases	-3,000	-3,000	-3,000	-3,000
Net Cash Surplus	385	2,498	4,365	2,990
Profit Calculation				
Cash Farm Surplus	48,173	52,407	56,418	53,211
Interest + Tax	-23,867	-25,079	-26,426	-25,183
Livestock value change	-12,437	2,167	21,005	588
Depreciation	-3,000	-3,000	-3,000	-3,000
Deferred Interest	0	0	0	0
Reval. Loans & CA	0	0	0	0
After Tax Profit	*8,869*	*26,495*	*47,997*	*25,616*
Drawings	-12,164	-13,073	-13,870	-13,281
Loans written off	0	0	0	0
Change to Equity	*-3,295*	*13,422*	*34,127*	*12,335*

Note:

5% interval: *A 5% interval of 200 simulations expressed as the average of the 9th, 10th and 11th runs ranked by net cash surplus.*

95% interval: *A 95% interval of 200 simulations expressed as the average of the 189th, 190th and 191st runs ranked by net cash surplus.*

Table 7: SBM farm budget outcomes for June

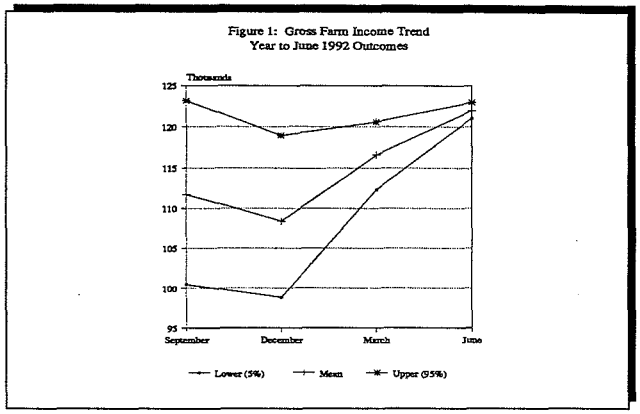
	5% Interval	Mean	95% Interval	Most likely
Sales				
- Sheep	48,118	48,728	49,428	48,559
- Cattle	29,039	29,086	29,122	29,090
- Wool	39,755	40,021	40,284	40,040
- Crops	0	0	0	0
Other Income	7,150	7,150	7,150	7,150
Purchases				
- Sheep	-1,200	-1,200	-1,200	-1,200
- Cattle	-1,800	-1,800	-1,800	-1,800
Gross Farm Income	*121,062*	*121,985*	*122,984*	*121,839*
Working Farm Expenses	-64,339	-64,339	-64,339	-64,339
- Discr. Component	0	0	0	0
Cash Farm Surplus	*56,723*	*57,646*	*58,645*	*57,500*
Interest Paid	-15,930	-15,903	-15,875	-15,907
Taxation	-9,646	-9,832	-10,018	-9,820
Mtg/Loan Repayments	-8,954	-8,954	-8,954	-8,954
Debt Retirement	0	0	0	0
Drawings	-14,158	-14,387	-14,639	-14,345
Development Exp	0	0	0	0
Capital Purchases	-3,000	-3,000	-3,000	-3,000
Net Cash Surplus	5,035	5,570	1,540	560
Profit Calculation				
Cash Farm Surplus	56,723	57,646	58,645	57,500
Interest + Tax	-25,576	-25,735	-25,893	-25,727
Livestock value change	-9,091	1,990	13,959	-429
Depreciation	-3,000	-3,000	-3,000	-3,000
Deferred Interest	0	0	0	0
Reval. Loans & CA	0	0	0	0
After Tax Profit	*19,056*	*30,901*	*43,711*	*28,344*
Drawings	-14,158	-14,387	-14,639	-14,345
Loans written off	0	0	0	0
Change to Equity	*-4,898*	*16,514*	*29,072*	*13,999*

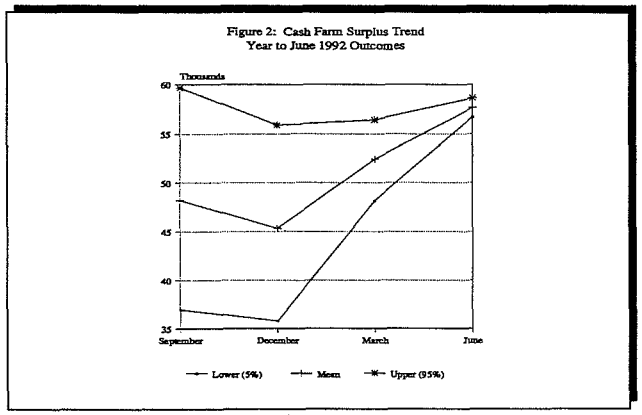
Note:

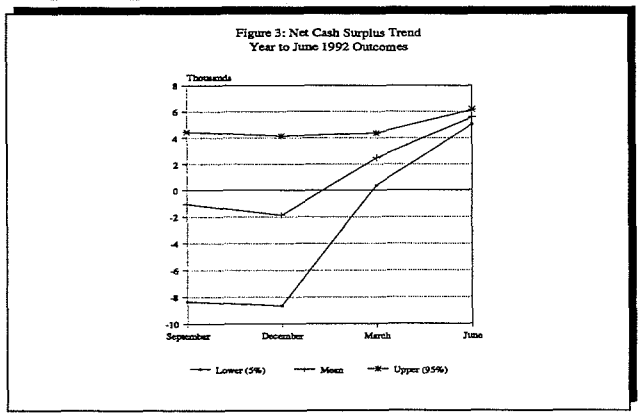
5% interval: *A 5% interval of 200 simulations expressed as the average of the 9th, 10th and 11th runs ranked by net cash surplus.*

95% interval: *A 95% interval of 200 simulations expressed as the average of the 189th, 190th and 191st runs ranked by net cash surplus.*

Figures 1 to 3 show the results with respect to FGI, CFS and NCS over the year of monitoring. An interpretation for say, NCS at the December round is that the actual year end outcome has a perceived mean of -$1,890 within a 90% probability range of -$8,646 and $4,153. There is also a 5% probability of the actual being outside this range at each end. As circumstances transpired, the June round indicated an actual beyond the upper range value. The mean for the June round was $5,570.







CONCLUSIONS

1 The anticipated perceived risk pattern was for a declining trend from September to June. What was observed, in addition to this, was that perceived risk increased from September to December and that this was largely due to factors aggregated into sheep sales, and lamb prices in particular. The actual year end outcome exceeded the 95% upper interval forecasted in September

2 There are differences in outcomes between the normal farm monitoring approach of assumed certainty and the SBM approach that explicitly takes into account risk relating to input variables of farm budget forecasts. This arises because of skewness in the underlying stochastic assumptions. While such differences are very minor for GFI and CFS, the differences for NCS are more significant.

3 Feed back from the farmers involved was favourable as they were more comfortable forecasting a range rather than simply a single point value. Some farmers, in forecasting ranges of values, tended to initially focus on a narrower range about the most likely than that given by the minimum and maximum.

4 The application of risk analysis to farm monitoring has its greatest worth in forecasting in the earlier periods of the financial year. The final forecasts for the June round still involves some risk though, since the data is obtained in May. It is considered that formalising risk into forecasts improves the quality of the results.

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PASTORAL SECTOR IMPACTS ON THE NEW ZEALAND ECONOMY

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SUMMARY

The pastoral sector in New Zealand, which comprises mainly sheep, beef, and dairy farming, accounts for more than 65 percent of the value of agricultural production, and when processed, over 85 percent of the value of agricultural based exports. Due to its critical importance to the New Zealand economy, responses of the pastoral sector to relative prices, costs and seasonal effects have extensive economy-wide implications.

Output, income and employment effects (known as Multipliers) arising from changes in the sheep, beef and the dairy farming sub-sectors during the 1986/87 year are calculated. In the case of sheep farming, each dollar's worth of sheep sector output from sheepmeats, wool etc generated a total impact on the economy of $6.17. This included a flow-on output effect of $5.17. In the case of employment, one million dollars worth of additional output (in 1986/87 prices) from sheep farming created 16 additional jobs in sheep farming itself and another 46 jobs elsewhere in the economy. This explanation is also extended to dairy and beef farming results in this paper. From every additional million dollars worth of output, more jobs were created in total from beef farming (108) than sheep farming (62) or dairy (85).

In order to examine the economy wide output, income and employment effects for recent years, the 1991 season's estimates of agricultural production were compared with the 1987 levels (the year of the latest available Inter-Industry study). Results show that the total output, income and employment impacts generated by the sheep farming sector were much lower in 1991 than in 1987, while those generated by the dairy farming sector were higher. The impact generated by the beef farming sector remained relatively constant over this period. The increases in dairy production was not large enough to offset the decline caused by the reduction in production from sheep farming. Total pastoral sector output, income and employment impacts were slightly lower in the 1991 season than in the 1987 season.

To study the implications of likely future output prospects for the pastoral sector, forecast period (i.e., 1992 to 1995) impacts were compared with the 1991 estimates at 1987 prices. It is envisaged that there will be improvements for the pastoral sector by 1995. For instance, in 1991 the pastoral sector generated 330,290 jobs in the economy, and this is expected to increase to 340,207 jobs in 1995. Beef and dairy farming prospects are better for 1995 than the 1991 estimates. The sheep farming sector's outlook for 1995 is expected to be considerably worse than that experienced in 1987.

Results also show that a very high proportion of total income is generated as a result of forward linkages ie from the processing of farm products. Proportions of output (80%) and employment (76%) generated by the processing of beef farming output are much higher than the corresponding figures for dairy (65% and 51%) and sheep (57% and 41%) farming.

The views expressed in this paper are those of the authors and not necessarily the views of MAF Policy.

It is important to note that all the output, income and employment projections presented in this paper are based on the 1986/87 Input:Output and Employment:Output ratios. These ratios may have changed for the current and forecast periods, either through improved efficiency of the industries, labour/capital substitution effects or through putting greater emphasis on adding value to farm products before they are exported.

INTRODUCTION

The pastoral sector in New Zealand accounts for more than 65% of the value of agricultural production and, once processed, over 85% of the value of agricultural based exports. Due to the critical importance of the pastoral sector (made up of sheep, beef and dairy activities) to the agricultural sector in particular and to the economy in general, output responses of the pastoral sector to changes in relative prices, costs and seasonal effects faced by farmers, have important economy wide implications.

Changes to the production levels in the pastoral sector, along with the associated changes in farm income levels, ripple out from the farm production sub-sector to affect other industries by backward and forward linkages. The backward linkage comprises the initial effect (ie direct impact), the first round effect (ie farmers purchasing inputs), second and subsequent round effects (ie industries that supply inputs to the farmers increase their purchases in turn), and consumption induced effects (ie households employed in all affected industries purchasing goods and services from others within the economy). The impact generated by the processing of farm products is the forward linkage. Both backward and forward linkages can be measured by using the Inter-Industry transactions table of the New Zealand economy.

Quantifying the inter-industry flows between the agricultural and non-agricultural sectors is complex and expensive. It has been undertaken in New Zealand only every five years in the past, and in the future will be carried out only every seven years (Statistics Department, Media Release, 1991). Input-output analysis requires much primary data which is obtained through surveys. This framework, however, provides for a direct and relatively quick means of determining the output, income and employment impacts on the wider economy, of changes in levels of pastoral sector output. The 1986-87 inter-industry transactions tables and the 1986 population census of sectoral employment were the main data sources for undertaking this study. The 1986 population census of employment data has been adjusted to reflect 1986/87 full-time equivalent employment levels and has also been adjusted for seasonal factors.

OBJECTIVES

This study was undertaken mainly to facilitate greater use and applications of a Pastoral Sector Supply Response Model developed within Policy Services (SriRamaratnam and Reynolds, 1989) in order to assess the income and employment implications of pastoral sector output variations. The specific objectives of this paper are therefore to:

establish a suitable framework to link results from the Pastoral Sector Supply Response Model with input-output methodology to facilitate further analysis;

- understand the relative importance of various sectors linked to the pastoral production sector;
- develop a methodology to compute output, income and employment multipliers that will include all forward and backward linkages;
- compute output, income and employment multipliers for the major pastoral sector activities (sheep, beef, and dairy);
- evaluate the output, income and employment impacts on other related sectors from projected pastoral sector output and inventory levels.

METHOD

In this section, a brief description of the Pastoral Sector Supply Response Model and its outputs is provided. This is followed by a discussion of the inter-industry transactions table available now at a much disaggregated level for the 1986/87 financial year and the steps required to transform these flows into direct input-output coefficients (ie transactions matrix) and the inter-dependency coefficients, including open and closed inverse matrices. Adjustment of employment data to account for part-time employment, self-employment and seasonal employment is also discussed. Subsequently, the computation of output, income and employment multipliers from the transactions matrix is outlined. This section also includes a brief discussion on the method used to adjust the multipliers calculated from the input-output tables for forward linkages.

Pastoral Sector Supply Response Model

An econometric time series model of the pastoral sector of New Zealand was developed to study the impacts of exogenous changes in product prices, cost of production, and seasonal factors on output levels of the main pastoral sub-sectors, that is, the sheep, beef and dairy industries. Pastoral farmers' responses to the physical and economic environment at the aggregate level are initially modelled with respect to the enterprise mix and then the supply response is further disaggregated by outputs. These outputs are the joint products of lamb, mutton and wool from the sheep sector; prime and manufacturing beef from the beef and/or dairy sectors; and veal and milkfat from the dairy sector.

The pastoral model provides estimates for over 100 endogenous variables which are related to production and livestock inventory levels of the sheep, beef and dairy sectors through a recursive dynamic simulation process. Within the model, some results are related to intermediate outcomes or decisions such as slaughter numbers and weights, births, deaths, transfers, promotions and breeding. Output in future periods can be increased only by increasing the size of the breeding flock or herd which implies withholding stock from slaughter in the current period. This requires a block recursive structure and a dynamic simulation framework to capture inter-relationships between the time periods and also the sectoral outputs. Physical output estimates for 1991 and those available for each year of the forecast period (1992-1995) and their real values in NZ$, are used to derive the economy wide impacts on the sectors related to pastoral production.

Inter-Industry Transactions

The Framework

An inter-industry study is an economic statement of the industrial structure of a nation's economy for a given year (eg 1986/87 financial year). It records how much each industry purchases from, and sells to, other industries and also measures the indirect relationships between industries. It can be used to show the probable effect throughout the economy of rises or falls in demand for one industry's products.

An inter-industry study requires the systematic collection, evaluation, and arrangement of a vast body of statistical information on production and consumption covering, to the extent possible, every area of the economy at a specified level of industry aggregation. The main sources of data for the agricultural industries are the economic surveys of farm types conducted by the Department of Statistics. Output is valued by the actual prices received at the point of sale. The itemisation of inputs for sheep and beef farming is obtained from the Meat and Wool Boards' Economic Services' (MWBES) sheep and beef surveys and for dairy farming is obtained from the Dairy Board's survey of Factory Supply dairy farms as well as the then Milk Board's survey of Town Milk farms.

The 1986/87 inter-industry transactions tables, which are the latest available for the New Zealand economy, are disaggregated to the 184 industry level. This level of disaggregation, compared with the more aggregated industry level for the 1981/82 and prior inter-industry tables, has enabled, for example, the assessment of impacts of changes in the sheep and beef sectors to be undertaken separately rather than as the sheep/beef farming system. Similar advantages are found in both the input supply and processing industries related to the pastoral sector. The key industries of specific interest are listed in Narayan and SriRamaratnam (1992). In some cases the listed industries represent the aggregation of the 1986-1987 inter-industry tables at the 184 industry level into a more manageable 80 industry table. This was achieved by selective aggregation of the less significant industries as they relate to the pastoral sector, while maintaining the disaggregation of the pastoral and related sub-sectors in the backward and forward linked industries.

Transformations

Once the desired level of aggregation was achieved, the 1986/87 inter-industry table which represents transactions between industries, was transformed into Direct Input-Output Coefficients which can then be manipulated to generate Inter-Dependency Coefficients. This transformation provides the Open Inverse Matrix, which measures indirect effects. When the household consumption sector is also included as part of the matrix to be inverted (along with all the intermediate demand sectors) the Closed Inverse Matrix is obtained, which includes both the indirect and consumption-induced effects of initial impacts.

The Direct Input-Output Coefficients (a_{ij}) are computed by dividing each column element (x_{ij}) of the Transactions Matrix (A) by its respective column totals of both intermediate and primary inputs. These coefficients are treated as constants and represent direct purchases of inputs (in cents) from other industries (represented along the rows) for every dollar's worth of output produced by the industries (represented by the different columns) in question. The inter-dependency coefficients (r_{ij}), on the other hand, measure both the direct and indirect inputs per dollar of sales to final demand from the industry identified.

Input-Output Multipliers

Multipliers measure economic consequences in terms of output, income or employment, resulting from changes to final demand. The amount of economic activity that the multiplier measures depends on the categories of effect that are taken into consideration. These can be either the initial effect (ie direct impact), the first round effects (ie farmers purchasing inputs), the industrial support effects or the second and subsequent round effects (ie industries that supply inputs to farmers increase their purchases in turn), and consumption induced effects (ie households employed in pastoral farming and backward-linked industries purchasing goods and services from others within the economy). These effects only account for the backward linkages of the industry in question. A significant amount of impact, especially for the pastoral sector, can be forward linked, ie processing of farm products. Backward and forward linkages combined with the initial impact give the total impact. The flow-on impact is the total impact less the initial impact.

Employment and income effects are estimated in an input-output model by using additional co-efficients representing the labour inputs or incomes paid per unit of output in each sector in the model. Once changes in output levels have been estimated from the input-output model, the employment and income effects of these changes are assessed by means of supplementary calculations.

A Simple Output Multiplier (direct and indirect output) can be obtained for each sector by summing the column vectors ($\Sigma_i r_{ij}$) of the inverted, Leontief Matrix (I-A), where r_{ij} represent the direct and indirect requirement from sector i for a unit increase in the Final Demand of sector j. The direct effect on *income* from an increase in the output of a sector can be estimated as the payments to households in sector j (H_j), expressed as a proportion of sector total output (X_j) and estimated as a co-efficient (W_j). The direct and indirect income (Y_j) resulting from an increase in Final Demand of a sector can be estimated through multiplying the vectors of the above coefficient (W_j) by the vector of simple output multiplier ($\Sigma_i r_{ij}$) computed before. As such, Y_j is the direct and indirect *Income Multiplier* for sector j, given an increase in sales to Final Demand.

To derive multipliers that include the consumption induced effects, the household row and column, formerly in the Primary Inputs and Final Demand columns respectively, must first be moved into the Transactions Matrix (A*), which is the original transaction Matrix (A) enlarged to n+1 sectors. This effectively treats households as an industrial sector and means that the household income generated as a result of the direct and indirect effects induces further increases in output and income through consumer spending. Accordingly, the *Total Output Multipliers* will be the sum of the elements in the column vectors ($\Sigma_i r^*_{ij}$) of the inverted expanded (n+1 sector), Leontief Matrix (I-A*), which includes the household sector (Hubbard and Brown, 1981).[1]

Employment Multipliers can be calculated in a similar fashion to income multipliers. As employment is not explicitly included in the inter-industry tables, a vector of employment: output co-efficients (U_i) is estimated exogenously, using the employment data described in the next section. These coefficients represent, for each sector, the amount of employment, (full-time equivalent and adjusted for seasonal employment) created by one million dollars of output. *Employment Multipliers* from the open model are thus obtained through multiplying the vector of column elements ($\Sigma_i r_{ij}$) by the employment coefficient (U_i).

[1] Note: The household coefficient is not included in the summing process since this would involve double counting, and since household income is not part of the standard definition of gross output (since it is a primary input).

These output, income and employment multipliers, produced from input-output analysis, as described above, assume that the product for which the multiplier is assessed is going into final demand. This assumption does not make sense for industries such as pastoral production which drive some of the processing industries such as meat works, manufacture of dairy products, wool scouring etc. Thus in addition to calculating the multipliers on the basis of backward linkages as described above, *forward linkages* of pastoral production are equally important. The method of calculating forward linkages is described in Butcher (1983), and is illustrated below.

Calculation of 'Employment Multipliers Including Forward Linkages', an illustration only.

- Using national technical coefficients from the input-output tables, assess the increase in processing unit production (eg meat works) for a unit increase in the primary industry (beef farm), (B); see Table 1, below.
- Assess the corresponding increase (C) in employment (direct, indirect and induced) arising from the increase in meat works production using the procedure for backward linkages just described.

  This will include the effects of increased on-farm employment (since this is a backward linkage of the meat works industry).
- Assess the direct increase (F) in on-farm employment arising from a unit increase in beef farm production.
- Divide F by C. This is the employment multiplier for beef farm production including forward linkages.

Table 1: Calculation of Employment Multiplier, An Illustration

	Increase in Output $m, 1986/87		Direct Increase in Employment		Multiplier		Employment
	Initial	Increase in Process Industry	per $m	For $1m Increase in Primary Industry	Calculated	Implicit	Total
	A	B		C	D	E=F/C	F=C*D
Beef Farming	1.00		10.01	10.01		10.77	107.77
Into Ham/Bacon		0.54	7.41	3.97	4.60		18.25
and Meat Works		2.59	6.42	16.62	4.80		79.85
and Grain Mill		0.17	5.52	0.92	5.69		5.23
and Animal Foods		0.16	3.52	0.56	7.98		4.44
and Exports		0.02	0.00	0.00	0.00		0.00

Note: A look at the section on results will make this illustration easier to follow. The steps involved in calculating output and income multipliers, including forward linkages, are similar to the procedure for calculating the employment multipliers as described above.

Seasonal Employment

The Labour Force Survey data from the 1986 Census of Population and Dwellings, was adjusted to reflect full-time equivalent employment for the 1986/87 financial year, to bring it into a common basis with the 1986/87 Inter-Industry Transactions table. Using the Quarterly Employment Survey data from the Department of Labour for the four quarters in the 1986/87 financial year, the Census full-time equivalent

employment data was adjusted to account for seasonal employment. Full-time equivalent employment, adjusted for seasonality, for the 80 industries is presented in Narayan and SriRamaratnam (1992).

Self-Employed Income

As described previously, the aim of including the household consumption sector as part of the matrix to be inverted was to estimate the increase in consumption which will result from increased production in a sector, and the increase in employment and output which will result from the increased consumption. Thus, one should be trying to establish the increase in household expenditure resulting from an increase in production in a sector. The approach taken in this paper, and also described in Butcher (1983) is to add together compensation of employees (ie wages, etc) and an estimate of income earned by the self-employed. From these payments to households, taxes are deducted to give disposable income, and savings are deducted to give the increase in consumption.

The procedure involves the following:

- Compensation of Employees (a), in $ million are recorded from Inter-Industry Transactions table.
- Determine the ratio of number of self-employed to number of employees (b), from employment data.
- Calculate the ratio of self-employed and employee income per person (c) (using census data).
- Calculate self-employed income (d) d=a*b*c.
- Calculate Gross Household Income (e) e=d+a.
- Calculate Household Disposable Income (f) f=0.76e.
- Calculate Household Consumption (g) g=0.94f.

The results of these calculations are reported in Narayan and SriRamaratnam (1992).

Impact Analysis

GRIMP, an input-output analysis program, developed by West (1988), was used to carry out all the Input-Output analysis reported in this paper. Computations outside of GRIMP were necessary to account for forward linkages.

Once the different multipliers are computed as outlined in previous sections, the value (in constant prices) of the pastoral sub-sector (ie, sheep, beef and dairy) output levels for the current year (1991) or for the forecast years (1992-1995) can be used to derive the corresponding output, income and employment impacts in the pastoral related backward and forward linked activities of the wider economy. By computing the corresponding impacts for the year (1986/87) in which the last inter-industry study was carried out in New Zealand, estimates for the current year and forecasts for the next four years can be verified.

While carrying out the impact analysis, it is important to recognise some of the limitations inherent in the Input-Output framework. These relate to the assumption of a set of fixed average co-efficients for industries in the economy since the time of the last study (1986/87), which implies a static environment without any structural changes in the interim. Because a linear production function is assumed, any economies of scale that may occur are ignored. The input-output technique however, possesses the advantage of being: (a) policy neutral; (b) an effective measure of economic inter-dependence of various sectors and industries; (c) able to produce long-run projections and forecasts of economic impacts; and (d) useful when detailed time-series data are lacking (Neild, 1990).

Average Versus Marginal Input Coefficients

The analysis in this paper is based on average input-output coefficients. Typically it can be argued that marginal, rather than average, coefficients should be employed in undertaking impact analysis, as the computed multipliers from the respective coefficients will produce somewhat different results. Small changes in the production levels of industries are usually not expected to produce employment and income effects associated with the average coefficients.

Although the idea of using marginal coefficients to reflect changes in input-output structure has a certain logical appeal, experiments on a series of Dutch national input-output tables for 13 consecutive years were not encouraging (Miller and Blair, 1985, p275). Forecasts using marginal coefficients gave results that were not as good as when the most recent table of average coefficients was used.

RESULTS AND DISCUSSION

The results will be presented in four parts. First, a summarised transactions matrix is presented together with the direct input-output coefficients for the pastoral sector and its supporting industries. The second section will cover the output, income and employment multipliers for the sheep, dairy and beef farming sub-sectors. This will be followed by a projection of pastoral sector output levels as anticipated at present by commodity analysts within MAF. Finally, using the multipliers and the pastoral sector projections, the forecast impacts of the sector on the economy are presented.

CAUTION:

All results presented in this paper are based on 1986/87 Input : Output and Employment : Output Ratios. The 1986/87 inter-industry study is the latest available. These ratios may have changed for the current year and may also differ for the forecast periods.

1986/87 Inter-Industry Coefficients

Destination of Outputs from the Pastoral Sector Industries

The direct input-output coefficients for the relevant pastoral sector industries and their supporting industries, derived from the 1986/87 inter-industry transactions tables, are shown in Table 2. The industries forming the column headings were chosen on the basis of the major destinations of the pastoral sector on-farm production. The table shows the proportion each pastoral industry contributes as an input to each of the processing industries forming the column headings. For instance, 20 percent of 'meat works' input come from sheep farming.

Table 2:	Direct Input-Output Co-efficients (1986/87)								
	Ham Bacon Smlgds	Meat Works	Milk Procss Plants	Ice-Cream Manuf	Dairy Prodts Manuf	Grain Mill Prodts	Prepd. Animal Feeds	Wool Scouring	Exports
80 Inds Code	15	16	17	18	19	23	25	27	
Sheep Farming	0.012	0.200				0.068	0.038	0.692	0.035
Dairy Farming	0.010	0.045	0.607	0.063	0.555				0.001
Beef Farming	0.024	0.112				0.043	0.027		0.001
Total	0.046	0.357	0.607	0.063	0.555	0.111	0.065	0.692	0.037

Although most of the cell values in Table 2 are very low, these processing industries and exports are the major destinations of the pastoral sector's production, as shown in Table 3. In the case of sheep farming, 33 percent of its total output is further processed at 'meat works', 27 percent is destined for 'wool scouring' and a further 22 percent are for 'direct exports'.

The destination of output from sheep, dairy and beef farming is shown in Table 3. Row (b) in Table 3 shows adjusted figures where all output (excluding inter-farm sales etc) goes to the processing and final demand sectors.

Table 3:	Destination of Agricultural Production (1986/87 Inter-Industry)									
	Ham Bacon Smlgd	Meat Works	Milk Procs Plants	Ice-Cream Manuf	Dairy Prodt Manuf	Grain Mill Prods	Prepd. Animal Feeds	Wool Scouring	Export	Total
80 Inds Code	15	16	17	18	19	23	25	27		
Sheep (a)	0.002	0.330				0.006	0.003	0.268	0.216	0.825
Farming (b)	0.003	0.424				0.007	0.004	0.346	0.216	1.000
Dairy (a)	0.004	0.134	0.063	0.004	0.728				0.007	0.940
Farming (b)	0.004	0.143	0.067	0.005	0.775				0.007	1.000
Beef (a)	0.018	0.685				0.014	0.008		0.021	0.746
Farming (b)	0.025	0.925				0.018	0.010		0.021	1.000

Notes: (a) Percentage of row total going to each industry
(b) Adjusted so that row totals of major industries sum to 1.00

1986/87 Multipliers for the Pastoral Industries

Because GRIMP only accounts for the backward linkage when calculating multipliers, computations outside of GRIMP were necessary to account for the forward linkages. The results presented here focus on backward and forward linkages in total and not separately.

To compute the multipliers, it is first necessary to assess the increase in processing unit's production from a unit increase in on-farm production. This is obtained by dividing the cell value in Table 3 (second row of each farming industry) by the column total from Table 2, for each processing industry and for exports. The results of these calculations are presented in Table 4.

Table 4:	Assessment of Increase in Processing Unit's Production From a Unit Increase in On-farm Production (1986/87 Inter-Industry Study)								
	Ham Bacon Smlgd	Meat Works	Milk Procss Plants	Ice-Cream Manuf	Dairy Prodts Manuf	Grain Mill Prodts	Prepd. Animal Feeds	Wool Scouring	Exports
80 Inds Code	15	16	17	18	19	23	25	27	
Sheep Farming	0.065	1.188				0.067	0.057	0.499	0.216
Dairy Farming	0.086	0.400	0.111	0.076	1.396	0.167	0.158		0.007
Beef Farming	0.536	2.591							0.021

The method employed to compute output, income and employment multipliers was discussed in the previous section. The results are presented in the following four sections.

Employment Multipliers

Column D in Table 5a shows the backward linked multipliers for each of the processing industries. These multipliers of the industries downstream (or forward) are used to calculate the multipliers, including forward linkages, for the sheep, beef and dairy farming activities. These multipliers, shown in Column E, are then used to calculate the employment ratios between on-farm and off-farm, as presented in Column B in Table 5b. Dividing Column C, in Table 5a, into one million dollars determines the extra output required from the farming activity to create one extra job on the farm. These figures calculated for sheep, dairy and beef farming are shown in Column A, in Table 5b.

Table 5(a):	Calculation of Employment Multipliers Including Forward Linkages						
	Increase in Output $m, 1986/87		Direct Increase in Employment		Multiplier		Employment
	Initial	Increase in Process Industries	Per $m	For $1m Increase in Primary Industry	Calculated	Implicit	Total
	A	B		C	D	E=F/C	F=C*D
Sheep Farming	1.000		16.096	16.096		3.846	61.901
Into Ham/Bacon		0.065	7.407	0.510	4.693		2.392
and Meat Works		1.188	6.416	7.624	5.282		40.268
and Grain Mill		0.067	5.517	0.367	5.774		2.120
and Animal Foods		0.057	3.519	0.200	8.168		1.633
and Wool Scour		0.499	0.980	0.489	31.646		15.488
and Exports		0.216	0.000	0.000	0.000		0.000
Dairy Farming	1.000		25.068	25.068		3.372	84.531
Into Ham/Bacon		0.086	7.407	0.639	4.904		3.131
and Meat Works		0.400	6.416	2.566	6.139		15.750
and Milk P Pln		0.111	7.364	0.818	5.577		4.561
and Ice-Cream Mnf		0.076	6.688	0.505	4.544		2.295
and Dairy P Mnf		1.396	3.841	5.362	10.964		58.794
and Exports		0.007	0.000	0.000	0.000		0.000

Table 5(a) (Contd): Calculation of Employment Multipliers Including Forward Linkages							
	Increase in Output $m, 1986/87		Direct Increase in Employment		Multiplier		Employment
	Initial	Increase in Process Industries	Per $m	For $1m Increase in Primary Industry	Calculated	Implicit	Total
	A	B		C	D	E=F/C	F=C*D
Beef Farming	1.000		10.008	10.008		10.768	107.767
Into Ham/Bacon		0.536	7.407	3.971	4.595		18.249
and Meat Works		2.591	6.416	16.622	4.804		79.853
and Grain Mill		0.167	5.517	0.919	5.686		5.228
and Animal Foods		0.158	3.519	0.556	7.977		4.438
and Exports		0.021	0.000	0.000	0.000		0.000
CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios							

The direct increases in employment (Table 5a, Column C) indicate the number of jobs per $million of output (at 1986/87 prices) in the primary industry. In the sheep farming industry $1 million of output in 1986/87 created 16 additional direct jobs (Table 5a, Column C, Row 1). For each job created on a sheep farm from this output, 2.85 jobs were created elsewhere in the economy to give a total of 3.85 jobs (Table 7a, Column E). This translates into one direct job for each $62,127 of industry output; the flow-on effects generated further output and employment so that in total, one job resulted from $16,137 of sheep farming output (see Table 5b).

Table 5(b): Summary of Employment Impacts (1986/87)		
	Value of Farm Output (1986/87 Prices) that Created ONE Job on the Farm	Jobs Off-farm for One Job On-farm
	A	B
1 Sheep Farming	$62,127	2.85 Jobs
2 Dairy Farming	$39,891	2.37 Jobs
3 Beef Farming	$99,920	9.77 jobs
CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios		

Output Multipliers

The output multiplier shown in Column E, in Table 6(a), includes forward linkages. This figure represents the total impact each of the farming sectors had on the total economy from a one dollar increase in its output in 1986/87. For instance, each dollars worth of sheep farming's output generated a total impact on the economy of $6.17.

For the sheep farming industry each dollar's worth of output generated flow-on output effects in 1986/87 of $5.17 (Table 6(b)), whereas in the case of beef farming the flow-on impact was $10.28. The components of the flow-on effects were described in an earlier section. Compared with beef farming, a high proportion of sheep farming's output was exported (Table 3). Also, a very high proportion of beef farming's output, compared with sheep farming, goes into meat works (Table 3), an activity which had a much higher output multiplier than wool scouring (Table 6(a), column B, meat works). Table 6(a) shows that all the industries processing dairy farm products also had low multipliers.

Table 6(a): Calculation of Output Multipliers Including Forward Linkages							
	Increase in Output $m, 1986/87		Direct Increase in Output		Multiplier		Output
	Initial	Increase in Process Industry	Per $m	For $1m increase in Primary Industry	Calculated	Implicit	Total
	A	B		C	D	E=F/C	F=C*D
Sheep Farming	1.000		1.000	1.000		6.166	6.166
Into Ham/Bacon		0.069	1.000	0.069	3.391		0.233
and Meat Works		1.188	1.000	1.188	3.263		3.877
and Grain Mill		0.067	1.000	0.067	3.238		0.215
and Animal Foods		0.057	1.000	0.057	3.316		0.188
and Wool Scour		0.499	1.000	0.499	3.308		1.652
and Exports		0.216	0.000	0.000	0.000		0.000
Dairy Farming	1.000			1.000		6.800	6.800
Into Ham/Bacon		0.086	1.000	0.086	3.443		0.297
and Meat Works		0.400	1.000	0.400	3.412		1.364
and Milk P Pln		0.111	1.000	0.111	3.186		0.354
and Ice-Cream Mn		0.076	1.000	0.076	3.092		0.234
and Dairy P Mn		1.396	1.000	1.396	3.260		4.551
and Exports		0.007	0.000	0.000	0.000		0.000
Beef Farming	1.000		1.000	1.000		11.277	11.277
Into Ham/Bacon		0.536	1.000	0.536	3.385		1.815
and Meat Works		2.591	1.000	2.591	3.240		8.394
and Grain Mill		0.167	1.000	0.167	3.253		0.542
and Animal Foods		0.158	1.000	0.158	3.324		0.526
and Exports		0.021	0.000	0.000	0.000		0.000
CAUTION: The results of this table are based on 1986/87 Input : Output and Employment : Output Ratios							

Table 6(b): Summary of Output Multipliers (1986/87)			
	Initial Impact	Total Impact	Flow-on Impact
1 Sheep Farming	1.0	6.17	5.17
2 Dairy Farming	1.0	6.80	5.80
3 Beef Farming	1.0	11.28	10.28
CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios			

Table 7(a): Calculation of Income Multipliers Including Forward Linkages

	Increase in Output $m, 1986/87		Direct Increase in Income		Multiplier		Income
	Initial	In Processing Industry	Per $m	For $1m Increase in Primary Industry	Calculated	Implicit	Total
	A	B		C	D	E=F/C	F=C*D
Sheep Farming	1.000		0.112	0.112		8.160	0.914
Into Ham/Bacon		0.069	0.119	0.008	4.614		0.038
and Meat Works		1.188	0.135	0.160	3.869		0.621
and Grain Mill		0.067	0.073	0.005	6.786		0.033
and Animal Foods		0.057	0.060	0.003	7.715		0.026
and Wool Scour		0.499	0.022	0.011	17.860		0.196
and Exports		0.216	0.000	0.000	0.000		0.000
Dairy Farming	1.000		0.218	0.218		5.068	1.105
Into Ham/Bacon		0.086	0.119	0.010	4.779		0.049
and Meat Works		0.400	0.135	0.054	4.379		0.236
and Milk P Pln		0.111	0.100	0.011	5.336		0.059
and Ice-Cream Mn		0.076	0.125	0.009	4.084		0.039
and Dairy P Mn		1.396	0.075	0.105	6.892		0.722
and Exports		0.007	0.000	0.000	0.000		0.000
Beef Farming	1.000		0.137	0.137		13.253	1.816
Into Ham/Bacon		0.536	0.119	0.064	4.622		0.295
and Meat Works		2.591	0.135	0.350	3.899		1.364
and Grain Mill		0.167	0.073	0.012	6.848		0.083
and Animal Foods		0.158	0.060	0.009	7.773		0.074
and Exports		0.021	0.000	0.000	0.000		0.000

CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios

Results in Table 7(b) show that a dollar of sheep farming output in 1986/87 led to 11 cents of household income for those employed in sheep farming, and generated a total household income of 91 cents in the economy (ie a flow-on of 80 cents). Beef farming output generated the highest flow-on income effect ($1.68) of the three main pastoral sector farming activities.

Table 7(b): Summary of Income Multipliers (1986/87)

	Initial Impact	Total Impact	Flow-on Impact
1 Sheep Farming	0.11	0.91	0.80
2 Dairy Farming	0.22	1.11	0.89
3 Beef Farming	0.14	1.82	1.68

CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios

Table 8 provides a summary of the multipliers for sheep, beef and dairy farming, using the 1986/87 Inter-Industry Transactions data and the 1986/87 employment statistics. The components of the total impact were described in an earlier section (input-output multipliers).

Table 8: Economy Wide Impacts From Additional Pastoral Sector Outputs

	Output		Income		Employment	
	Multiplier	Per $	Multiplier	Per $	Multiplier	Per $m
Sheep Farming						
Initial Impact		1.00		0.11		16
Total Impact	6.17	6.17	8.16	0.91	3.85	62
Flow-on Impact	5.17	5.17	7.16	0.80	2.85	46
Dairy Farming						
Initial Impact		1.00		0.22		25
Total Impact	6.80	6.80	5.07	1.11	3.37	85
Flow-on Impact	5.80	5.80	4.07	0.89	2.37	60
Beef Farming						
Initial Impact		1.00		0.14		10
Total Impact	11.28	11.25	13.25	1.82	10.77	108
Flow-on Impact	10.28	10.28	12.25	1.68	9.77	98

CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios

Consideration of the multipliers in Table 8 reveals some important characteristics of the pastoral sector. The proportion of flow-on impact to initial impact in 1986/87 was very high for the three pastoral sector industries. Beef farming had the highest flow-on multiplier of the three. One major reason for the low sheep farming multiplier was that sheep farming had the highest proportion of its products directly exported (as raw wool). Also, a very high proportion of beef farming's output, compared with sheep farming, went into meat works. Meat processing had a much higher multiplier effect than wool scouring. The low multipliers for dairy farming were mainly because all the industries involved in processing dairy farm products had lower multipliers than meat works (Table 7(a) column B).

Pastoral Sector Price Assumptions and Output Responses

Prices for lamb, mutton and wool from the sheep farming sector, and beef and milkfat from the beef and dairy farming sectors respectively, are employed in the pastoral model. This along with cost and seasonal weather indices for each farming activity are used as exogenous variables to derive farmer output responses to these price, cost and seasonal factors.

A 'most likely' scenario as anticipated at present (April 1992) by commodity analysts within MAF, based on overseas market prospects for our primary pastoral outputs in major export markets has been used in the analysis here.

Price Forecasts

Nominal lamb prices, at farm-gate, are anticipated to remain unchanged this season (ie, 1991/92) relative to prices received during the 1990/91 season, which averaged 192c per kg (Table 9). In subsequent seasons, lamb price is expected to increase substantially to be about 30 percent higher, in nominal terms, at the end of the forecast period (ie, 1994/95 season) relative to last season's prices. Nominal mutton prices at farm-gate are expected to decline in 1991/92. However, prices are expected to recover substantially during the next three seasons to be about 40 percent higher, in nominal terms, in 1994/95, compared to the 1990/91 season. Greasy wool prices are expected to decline by about 10 percent in 1992 but are forecast to then rise rapidly to about 558c per kg in 1994/95, compared to about 350c per kg during the 1990/91 season (Table 9).

The prices of prime and manufacturing beef are also forecast to remain similar in 1991/92 to 1990/91 prices in nominal terms. They are expected to improve by about 5% in 1993 and then decline to below 1990/91 levels. Milkfat prices, on the other hand, are expected to increase substantially (ie by about 75 percent) during the forecast period (1992-95) compared to last season (1990/91).

Prices for all major pastoral ***meat*** products are therefore, forecast to remain steady this season (1991/92) compared to last season, and then to increase to varying degrees by the 1994/95 season, the last period of forecast (Table 9). Wool prices on the other hand decline in 1992 and then increase significantly, while milkfat prices increase steadily through to 1995.

Output Responses

Corresponding output responses, estimated by the Pastoral Model, in response to the above nominal prices at the farm-gate level, are lamb production to decline substantially during 1992/93 and beef production to increase steadily. Milkfat, mutton and wool production are anticipated to be somewhat higher this season as well. During the next three seasons, lamb and wool production are forecast to decline steadily, but by less than 5 percent annually. Mutton production however, will remain fairly steady, due to the large mutton price increases forecast.

Beef production is expected to increase somewhat, but by less than 10 percent annually during the seasons following this season (1991/92). Dairy milkfat production is forecast to increase steadily by about 3 to 4 percent during the three seasons up to the 1994/95 season (Table 9).

Value of Output

The nominal value of output from these main pastoral activities (ie sheep, beef and dairy) are reported in Table 9, where the outputs are valued at their respective farm-gate level. These values are also reported in 1986/87 actual prices and in real terms using the Producer Price Index (PPI) for outputs (NZIER, 1991). Sheep sector values include lamb, mutton and wool production in corresponding years, and beef production is valued using a weighted price of prime (0.20) and manufacturing (0.80) beef, which reflects their general share in total beef output (Table 9).

Table 9: Pastoral Sector Projected Output Levels and Underlying Price Scenario

	1990/91	1991/92	1992/93	1993/94	1994/95	1986/87[1]
NOMINAL PRICES, c/kg						
(a) Lamb	191.9	198.9	219.3	225.5	238.9	165.0
(b) Mutton	59.9	51.3	64.0	72.0	81.9	58.4
(c) Wool	351.0	323.3	440.3	481.5	558.0	416.7
Prime Beef	269.7	257.1	267.0	265.2	258.7	182.5
Manuf Beef	217.2	211.5	219.7	218.2	212.9	139.1
(d) Beef (weighted average)	227.7	220.6	229.2	227.6	222.1	147.8
(e) Milk Fat	424.0	516.0	634.0	694.0	742.0	355.0
OUTPUT, ('000 t)						
(a) Lamb	367.8	388.4	316.4	303.9	300.7	435.7
(b) Mutton	146.0	149.5	140.6	142.6	146.1	179.7
(c) Wool	305.3	307.0	285.0	284.9	283.5	349.5
(d) Beef	525.3	535.3	587.5	636.6	641.6	550.6
(e) Milk Fat	387.8	398.3	391.3	398.8	414.6	331.7
NOMINAL VALUE, $m						
(a) Sheep	1,864.9	1,841.8	2,038.7	2,159.8	2,420.0	2,280.2
(b) Beef	1,196.1	1,181.0	1,346.3	1,488.9	1,424.3	813.7
(c) Dairy	1,644.3	2,055.2	2,480.8	2,767.7	3,076.3	1,177.5
REAL VALUE, $M (Using Actual 1986/87 Prices)[2]						
(a) Sheep	1964.3	1864.1	1759.9	1756.8	1746.2	2280.2
(b) Beef	776.3	815.5	865.7	935.0	956.4	813.7
(c) Dairy	1376.7	1372.1	1341.2	1411.1	1466.9	1177.5
PPI Output[3]	1,756.0	1,806.0	1,895.0	1,956.0	2,025.0	1,443.0
REAL VALUE, $m (Deflated by PPI to 1986/87 Prices)						
(a) Sheep	1,532.5	1,471.6	1,552.4	1,593.3	1,724.4	2,280.2
(b) Beef	982.9	943.6	1,025.2	1,068.9	1,014.9	813.7
(c) Dairy	1,351.2	1,642.1	1,889.1	2,041.8	2,192.2	1,177.5

[1] The 1986/87 season prices and levels of output are presented here, as they will be compared with the outputs of the 1990/91 season and the forecast period.

[2] The forecast outputs are valued using the actual 1986/87 product prices to analyse the impact of changes in the volume of output, excluding any impacts from real price changes.

[3] Producer Price Index was used to deflate all the prices to 1986/87 levels. Although commodity specific indices may give better results, they are not available for any forecast period.

Results of Impact Analysis

The values of outputs, in 1986/87 actual prices, from the pastoral sub-sectors, reported in Table 9, are used along with the output, income, and employment multipliers, reported earlier, to compute the economy-wide impacts of changes in these outputs. This has been carried out under a most likely scenario for the forecast period (1992-95) and compared with actual impacts during last season (1990/91), as well as the season (1986/87) during which the last input/output study was carried out. These results are reported in Tables 10 and 11 and then summarised in Table 12.

Impacts on the Economy in 1991 Compared with 1987

The impacts of the sheep, beef and dairy farming activities for the year ending 31 March 1987, on the New Zealand economy are shown in Table 10(a). These results show that these three industries together generated over $31.6 billion of output, provided approximately 335,000 jobs and created over $4.9 billion in income for

households in the total economy. Of these values $27.1 billion in output, $4.2 billion in income and 256,000 jobs were flow-on effects to the rest of the economy, while the remainder were initial or direct effects.

Out of the total impacts of $31.6 billion output in 1986/87, sheep farming accounted for $15 billion, dairy farming $9.1 billion, and beef farming $7.4 billion. In terms of total employment (336,000 jobs) generated in the wider economy in upstream and downstream activities, sheep farming accounted for about 151,000 jobs, dairy farming 113,000 and beef farming, 71,000 jobs. The share of jobs created from the initial impact was about 25 percent of the total number of jobs created by the total pastoral sector. This ratio was higher for dairy and sheep farming but lower for beef farming.

Table 10(a): Pastoral Sector Impacts In 1987

Sectors/Impacts	Initial Impact	Total Impact	Flow-on Impact
I OUTPUT ($'m, 1986/87 Prices)			
Sheep Farming	2440	15046	12606
Dairy Farming	1342	9125	7783
Beef Farming	657	7409	6752
Total	4439	31580	27141
II INCOME ($'m 1986/87 Prices)			
Sheep Farming	273	2230	1957
Dairy Farming	293	1483	1190
Beef Farming	90	1193	1103
Total	656	4906	4250
III EMPLOYMENT (No. of Jobs)			
Sheep Farming	39274	151038	111764
Dairy Farming	33641	113441	79800
Beef Farming	6575	70803	64228
Total	79491	335282	255792

CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios

Corresponding estimates for the most recent year (1990/91) are shown in Table 10(b). These show that the total output ($12.96 b), income ($1.92 b) and employment (130,000 jobs) generated by the sheep farming sector in 1990/91 have declined, compared to $15 b, $2.2 b, and about 151,000 jobs respectively in 1986/87, while the dairy farming sector experienced an increase in these impacts. There was very little decline in impact generated by the beef farming sector. The increase generated by the dairy farming sector was not large enough to offset the decline caused by the reduction in production from sheep farming.

The value of total output from the three sectors in 1990/91 was $30.7b, while the total income was $4.8b and total employment 330,000, compared to $31.6b, $4.9b and 335,300 jobs respectively during the 1986/87 season. The total employment in 1990/91 was made up of about 130,000 jobs in the sheep sector, around 132,600 in the dairy sector and 67,550 in the beef sector compared to about 151,000, 113,000 and 71,000 jobs respectively, in the three sectors during the 1986/87 season.

Table 10(b): 1991 Versus 1987 Pastoral Sector Impacts[1]

Sectors	1991 Initial Impact	1991 Total Impact	1991 Flow-On Impact	Difference (91 vs 87) Total Impact	Difference (91 vs 87) Flow-On Impact
I OUTPUT ($'m, 1986/87 Prices)					
Sheep Farming	2102	12962	10860	-2084	-1746
Dairy Farming	1569	10669	9100	1543	1316
Beef Farming	627	7068	6441	-340	-310
Total	4298	30699	26401	-882	-740
II INCOME ($'m, 1986/87 Prices)					
Sheep Farming	235	1921	1686	-309	-271
Dairy Farming	342	1734	1391	251	201
Beef Farming	86	1138	1052	-55	-51
Total	663	4793	4129	-113	-120
III EMPLOYMENT (No.of Jobs)					
Sheep Farming	33833	130114	96280	-20925	-15484
Dairy Farming	39331	132627	93296	19186	13496
Beef Farming	6273	67550	61277	-3253	-2951
Total	79437	330290	250853	-4992	-4938

CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios

[1] This analysis is based on actual 1986/87 prices, and therefore excludes any impact of real price change.

Impacts on the Economy Under the Forecast Scenario

The average output, income and employment impacts under the forecast scenario for the period 1992-95 provided in Table 11(a) show that the pastoral sector, on average, is expected to provide 333,000 jobs in the economy. The highest contribution by the sector to national employment is expected to be around 340,000 in 1995 (Table 11(b)). This is based on the assumption that higher real prices will lead to increased production and processing.

Table 11(a): Pastoral Sector Impacts, Forecast Scenario (1992-95 Averages)[1]

Sectors/Impacts	Initial Impact	Total Impact	Flow-on Impact
I OUTPUT ($'m, 1986/87 Prices)			
Sheep Farming	1907	11757	9850
Dairy Farming	1593	10832	9239
Beef Farming	721	8132	7411
Total	4221	30722	26501
II INCOME ($'m, 1986/87 Prices)			
Sheep Farming	214	1742	1529
Dairy Farming	347	1760	1413
Beef Farming	99	1309	1211
Total	660	4812	4152
III EMPLOYMENT (No.of Jobs)			
Sheep Farming	30689	118021	87332
Dairy Farming	39934	134662	94728
Beef Farming	7217	77718	70501
Total	77841	330401	252561

[1] This analysis is based on actual 1986/87 prices, and therefore excludes any impact of real price change.

Table 11(b): Pastoral Sector Impacts, Forecast Scenario (1995)[1]			
Sectors/Impacts	Initial Impact	Total Impact	Flow-on Impact
I OUTPUT ($'m, 1986/87 Prices)			
Sheep Farming	1869	11523	9654
Dairy Farming	1672	11367	9696
Beef Farming	772	8709	7936
Total	4313	31599	27286
II INCOME ($'m, 1986/87 Prices)			
Sheep Farming	209	1708	1498
Dairy Farming	364	1847	1483
Beef Farming	106	1402	1296
Total	680	4957	4277
III EMPLOYMENT (No.of Jobs)			
Sheep Farming	30077	115668	85591
Dairy Farming	41907	141314	99407
Beef Farming	7729	83225	75496
Total	79713	340207	260494

[1] The forecast output is valued at actual 1986/87 price levels.

CAUTION: The results in these two tables are based on 1986/87 Input : Output and Employment : Output Ratios

The contributions to the economy's output, income and employment over the forecast period (1992-95) are slightly above the 1991 levels for pastoral farming sectors [see table 13(c)]. There are around 10,000 further job increases indicated in the beef sector, and about 2,000 job increases in the dairy sector. However, around 12,000 jobs will be lost from the sheep sector. In terms of total output, the gain in the pastoral farming sectors compared to 1990/91 is forecast to be around $23 million. This only accounts for the volume change, since all output are valued using actual 1986/87 prices.

Table 11(c): 1992-95 Forecast (Annual Average) Versus 1991 Impacts*			
Sectors/Impacts	Initial	Total	Flow-on
I OUTPUT ($'m, 1986/87 Prices)			
Sheep Farming	-195	-1205	-1009
Dairy Farming	24	164	140
Beef Farming	94	1064	970
Total	-77	23	100
II INCOME ($'m, 1986/87 Prices)			
Sheep Farming	-22	-179	-157
Dairy Farming	5	27	21
Beef Farming	13	171	158
Total	-4	19	23
III EMPLOYMENT (No.of Jobs)			
Sheep Farming	-3144	-12093	-8948
Dairy Farming	603	2035	1431
Beef Farming	944	10168	9224
Total	-1597	111	1707
CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios			

* 1992-95 Average (as in Table 11(a)) Minus 1991 (as in Table 10(b)).

[1] This analyses uses actual 1986/87 prices to value all pastoral sector products, in the different seasons.

Total Pastoral Sector Net Impacts on the New Zealand Economy

Table 12 summarises the net impacts (output, income and employment) of the total pastoral sector on the New Zealand economy.

The average annual output, income and employment impacts under the forecast scenario (1992-1995) are slightly higher than 1991 levels for the dairy and beef farming sectors, but a further decline is expected in the case of sheep farming sector. It is envisaged that there will be significant improvements from the dairy and beef farming sectors by 1995. For instance, in 1991 the dairy sector generated 132,600 jobs in the economy, and this is expected to increase to 141,000 jobs in 1995. Results presented in Table 12 show that the prospects for dairy and beef subsectors are better in 1995 than the 1991 estimates. Sheep farming's outlook for 1995 is expected to be considerably worse than that experienced in 1987. The total output, income and employment impacts for the pastoral sector in 1995 however, will be somewhat higher than both the 1987 and the 1991 levels.

Table 12: Total Impacts of Pastoral Sector Physical Output on the New Zealand Economy				
Sectors/Impacts	1987	1991	Forecast Impacts	
	Actual Impacts	Estimated Impacts	Ave 1992-95	1995
I OUTPUT ($'m, 1986/87 Prices)[1]				
Sheep Farming	15,046	12,962	11,757	11,523
Dairy Farming	9,125	10,669	10,832	11,367
Beef Farming	7,409	7,068	8,132	8,709
Total	31,580	30,699	30,722	31,599
II INCOME ($'m, 1986/87 Prices)				
Sheep Farming	2,230	1,921	1,742	1,708
Dairy Farming	1,483	1,734	1,760	1,847
Beef Farming	1,193	1,138	1,309	1,402
Total	4,906	4,793	4,812	4,957
III EMPLOYMENT (No.of Jobs)				
Sheep Farming	151,038	130,114	118,021	115,668
Dairy Farming	113,441	132,627	134,662	141,314
Beef Farming	70,803	67,550	77,718	83,225
Total	335,282	330,290	330,401	340,207
CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios				

[1] Output, income and employment impacts are based on actual 1986/87 prices, and therefore excludes any impact of real price change.

Economy-wide Impacts from Output as well as Real Price Increases

The output, income and employment impacts discussed above were based on the changes in the volume of sheep, beef and dairy farming output. This analysis did not account for any changes in impact that would have arisen from changes in real prices of the products.

When Producer Price Index (PPI) for outputs is used as a deflator, as in Table 9, real price increases are forecast for the sheep, beef and dairy farm products during the

1992-95 period. Results presented in Table 13 show the combined effects of changes in the volume of output together with the changes in the real price of farm products.

Table 13: Total Impacts of Pastoral Sector Real Output Value on the New Zealand Economy[1]

Sectors/Impacts	1987	1991	Forecast Impacts	
	Actual Impacts	Estimated Impacts	Ave 1992-95	1995
I OUTPUT ($'m, 1986/87 Prices)[1]				
Sheep Farming	15,046	10,112	10,462	11,379
Dairy Farming	9,125	10,471	15,044	16,988
Beef Farming	7,409	8,950	9,225	9,241
Total	31,580	29,533	34,731	37,608
II INCOME ($'m, 1986/87 Prices)				
Sheep Farming	2,230	1,499	1,550	1,686
Dairy Farming	1,483	1,701	2,444	2,760
Beef Farming	1,193	1,441	1,485	1,488
Total	4,906	4,641	5,480	5,935
III EMPLOYMENT (No.of Jobs)				
Sheep Farming	151,038	101,508	105,017	114,225
Dairy Farming	113,441	130,170	187,020	211,189
Beef Farming	70,803	85,529	88,161	88,316
Total	335,282	317,207	380,199	413,730

CAUTION: The results in this table are based on 1986/87 Input : Output and Employment : Output Ratios

[1] Output, income and employment impacts are based on prices deflated to 1986/87 levels using PPI-Output.

Comparing 1995 forecast output, income and employment impacts with the estimated 1991 impacts, significant improvements are envisaged from the three pastoral sector industries. The value of output from the sector increases from $29.5b in 1991 to $37.6b in 1995. Total income is forecast to increase from $4.64b in 1991 to $5.94b in 1995. Total employment to be generated by the sector is also expected to increase from 317,207 to 413,730 over this period.

Most of the increases in output, income and employment impacts are forecast to occur as a result of increases in real price and quantity of output in the dairy farming sector. For instance, milkfat price, reported in Table 9, is forecast to increase in real terms by 52 percent between 1991 and 1995, and the quantity of output is also expected to increase by about 7 percent. During this period, the quantity of lamb and wool production is expected to decline, although the price of lamb and wool are forecast to increase. In the case of beef farming, quantity of output is expected to increase by around 22 percent, but its real price is forecast to decline by 15 percent between 1991 and 1995. Additional beef output is generated by the expanding dairy industry.

Distribution of Employment Impacts from Pastoral Sector Production

Results presented in Table 14 show that employment generated by the sheep farming industry is not concentrated in any one sector. It is well spread between on-farm employment, employment in industries supplying inputs and services to the sheep farmers, and those employed in handling and processing farm products. In the case of dairy farming, employment is mainly split among those working on the farm and those handling and processing dairy farm products. However, in the case of beef farming, three out of every four jobs generated are in the handling and processing of farm products.

Table 14: Distribution of Employment Impacts from Pastoral Sector Production, 1986/87 Year

	On-Farm Employment %	Backward Linked Employment %	Forward Linked Employment %
Sheep Farming	26	33	41
Dairy Farming	30	19	51
Beef Farming	9	15	76

Sheep farming has a lower proportion of job creation in the handling and processing of farm products, compared to dairy and beef farming, because a lot of wool is exported without any further processing. Beef farming is not a labour intensive enterprise, and therefore does not generate as much on-farm employment. However, nearly all of its products get further processed on-shore, which is also very labour intensive. Therefore, a very high proportion of employment generated by beef farming is in the handling and processing sectors.

The industries in which the majority of backward linked employment impacts occur as a result of sheep, dairy and beef farming are:

- Wholesale and Retail Trade Services;
- Veterinary Services;
- Pastoral Contracting Services; and
- Banking, Finance and Investment Services.

Thus, employment is not only generated in the industries that manufacture farm inputs but also in the industries that handle farm inputs and those that provide services to farmers.

Results in Table 14 show that a lot more jobs are generated in industries which handle and process farm products than on-farm and input supply industries. On the processing side, employment is mainly generated in the meat works industry and in manufacturing dairy products. These two processing industries also generate a lot of employment in service industries, such as wholesale and retail trade, veterinary services and in banking, finance and investment services.

DISCUSSION AND CONCLUSIONS

This study was undertaken to develop a better understanding of the economy-wide impacts of changes in sheep, beef and dairy farming activities, forecast by a Pastoral Supply Response Model operational within MAF Policy Services. The measurement of wider impacts in terms of output, income and employment in the overall economy, both in downstream (ie processing, transportation, etc) and upstream (ie input supply, contracting services, etc) activities, was essential to interpret the output responses produced by the pastoral model more fully, in policy analysis as well as in forecasting exercises.

In order to achieve this, the Pastoral Model results had to be linked to the inter-industry transactions framework and employment data, which provide the necessary output, income and employment multipliers. The latest available Inter-Industry data was for the 1986/87 financial year and the Full-time Equivalent Labour Force (adjusted for seasonality in employment) data was computed for the 1986/87 year.

The results presented in this paper are further refinements of MAF Policy work by SriRamaratnam and Narayan (1991) presented at last year's conference. These results, unlike the results reported in the previous paper, account for both backward and forward linkages. They also include an adjustment of the operating surplus and compensation for employees data to reflect higher self-employment in the primary production sector. Adjustment of employment data was also necessary to include part-time employment and to account for seasonality in employment.

A forecast price scenario for lamb, mutton, wool, beef and milkfat was used in the Pastoral Supply Response model to produce pastoral output responses for the forecast period (1992-95). These forecasts were compared with the most recent season (1990/91) for which data is available, and a past season (1986/87), when the inter-industry data was compiled. The Pastoral Model output projections were then valued at 1986/87 prices, in order to assess the on-farm and total impacts of changes in the quantity of output. These output values for sheep, beef and dairy farming activities were used with the respective Output, Income and Employment Multipliers to estimate the corresponding impacts on the wider economy. Both individual sub-sector and the total pastoral sector results are reported in terms of initial impacts as well as total impacts, including flow-on effects.

The total impacts of the pastoral sector, as presented in this paper, show that total output, income and employment impacts generated by the sheep and the beef farming sectors were much lower in 1991 than in 1987, while those from the dairy farming sector were a lot higher. The increases from the dairy sector were not large enough to offset the decline caused by the reduction in production from sheep and beef farming. Total pastoral sector output, income and employment impacts were slightly lower for the 1991 season in comparison to the 1987 season.

The average annual output, income and employment impacts under the forecast scenario (1992-1995) are higher than 1991 levels for the dairy and beef farming sectors. It is envisaged that there will be further improvements from the pastoral sector by 1995. For instance, in 1991 the pastoral sector generated 330,290 jobs in the economy, and this is expected to increase to 340,207 jobs in 1995. The prospects for the dairy and beef farming sectors are better for 1995 than the 1991 estimates. Sheep farming's outlook for 1995 is expected to be considerably worse than that experienced in 1987. The total output, income and employment impacts for the pastoral sector in 1995 however, will be somewhat higher than in both 1987 and 1991.

It is important to note that all the output, income and employment projections presented in this paper are based on the 1986/87 Input:Output and Employment: Output ratios. These ratios may have changed for the current and forecast periods, either through improving efficiency within the industries, labour/capital substitution effects or through putting greater emphasis on adding value to farm products before they are exported. The new Input:Output and Employment:Output ratios will not be available until around 1997, when the next inter-industry study has been analysed.

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CAPITAL STOCK IN NEW ZEALAND AGRICULTURE 1967 - 1990

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ABSTRACT

New estimates of stock of capital employed in New Zealand farming for the period 1967 to 1990 are presented. Previous methodologies have been reviewed and up-dated. The gross capital stock concept is employed and comparisons made with market values of depreciated stocks. Two base assessments of the stock have been established for 1967 and 1988 and perpetual inventory method is used to generate intermediate years. Comparison of the two inventory bases gives an independent estimate of the real rate of economic depreciation of the farm asset in New Zealand. This gives indicative information on the rates used by the Inland Revenue Department.

INTRODUCTION

The original work in this area was carried out at Lincoln College in the 1960s (Philpott and Stewart 1958, Francis 1968, Philpott and Hussey 1969, and Johnson 1970). These studies built up by an increasing level of sophistication a picture of the farm economy in New Zealand that had not previously been attempted by official statisticians or other researchers.

The aim of the research was to construct total productivity models so that the components of productivity could be determined including the Solow residual (Johnson, 1972). Subsequently the data set was used for an investment-production model of the agricultural economy (Laing and Zwart 1983) and for assessing the returns to extension and science expenditure in agriculture (Scobie and Eveleens 1986).

The basis of the original capital stock model was determined before the Statistics Department introduced the capital expenditure question in its annual agricultural census. Levels of capital expenditure on farms were determined from secondary sources and related to a base year inventory on the June year ending 1967. The annual stock series were then derived by extrapolating on each side of 1967 by the real amount of net investment after depreciation in each year.

When the Statistics Department series was introduced in 1966 the secondary series calculations were suspended and the census data substituted in real terms for the following years. It is important to note that for the years before 1966 the only data available is still the Johnson (1970) estimates.

This early work was completed by estimating the real rate of economic depreciation between 1946 and 1967 by comparing the real value of the assets at the beginning and the end of the period and estimating what "capital" had disappeared after allowing for real additions. In effect this method is a "wastage" or "decay" way of approaching the problem but it still has heuristic value as a way of checking the Inland Revenue Department's allowances for depreciation and also understanding the real underlying structure of capital stocks and increments in the farm industry.

NEW METHODOLOGY

The new methodology returns to basics and attempts to more narrowly confine the concept of capital to the gross replacement cost principle (OECD 1976, 1988). This can be achieved by identifying two years some distance apart where data on a complete inventory is available. This then allows the analyst to identify all capital assets currently in use in the base years and avoids setting up a time profile of decaying assets. In effect if the asset has dropped out between base years it is regarded as completely used up. All current assets in use are then valued at replacement cost. This methodology does beg the question on any change in the average age of a stock of capital of course.

The earlier paper (Johnson 1970) used a mixture of the various methods for the valuation of stocks. Improvements to land were valued at replacement cost at 1966/67 prices; but buildings were valued at depreciated cost by drawing on the average value in the New Zealand Meat and Wool Boards' Economic Service data. For plant and machinery depreciated stock in 1949/50 prices, as estimated by Philpott and Hussey (1969), was used; and for livestock 1949/50 standard values were used. The latter approximate more to the low end of market value rather than true replacement cost. In each year the 1949/50 values account for the change in numbers but do not account for changes in age distribution for example.

In this paper, most of the gross stock of land improvements, buildings and machinery is counted and valued at replacement cost. Some indirect methods of estimation were used where the inventory was not complete and transparent. Livestock were valued at average market values as derived for tax purposes in 1987/88 (Wallis, pers com), and Lincoln College Financial Budget Manual (Lincoln College, 1966) values for 1966/67 were adjusted to the equivalent of average market values.

Converting the inventories to market values or depreciated cost turned out to be more difficult. The replacement value of land improvements was used for both valuations. For buildings, market values were derived from the Meat and Wool Boards' Economic Service sample data and grossed up by the number of full-time farms. For machinery, the replacement value was depreciated by 66 per cent to represent a decay rate of 15 percent over a life of 10 years. The market value estimates of capital are admitted to be more imprecise than those for replacement cost, mainly because of lack of data on age structure of the stock of capital.

The annual expenditure on capital goods was taken direct from the Statistics Department survey and deflated by the department's Capital Expenditure Price Index series to give real capital investment by categories; land improvements, buildings, plant and machinery, and livestock. This is a gross investment series (see Table 1) and has not been corrected for wastage or depreciation. As compared with the 1968 project, no direct estimates were made of the wastage of land improvements.

Table 1: Gross Annual Investment in Stock of Capital, 1967 to 1990					
Year	Land Improvements $'m,Real*	Buildings $'m,Real	Plant and Machinery $'m,Real	Livestock (Changes) $'m,Real	Total $'m,Real
1967	340.7	416.9	300.8	214.4	1272.8
1968	307.9	311.7	259.2	167.3	1046.1
1969	286.0	273.3	249.3	96.0	904.6
1970	281.4	256.9	242.9	74.6	855.9
1971	257.7	258.9	275.9	-16.5	776.0
1972	172.2	278.5	406.6	-11.7	845.7
1973	234.2	342.4	535.7	12.2	1124.5
1974	264.8	401.9	490.1	113.4	1270.2
1975	187.7	410.9	340.7	-21.7	917.6
1976	193.7	388.8	379.3	-61.8	899.9
1977	191.3	404.0	401.0	-27.1	969.1
1978	183.5	374.5	301.7	-42.0	817.7
1979	230.5	355.0	401.7	-93.3	893.9
1980	245.2	410.7	415.0	175.2	1246.1
1981	278.9	468.2	439.5	-5.7	1180.8
1982	300.4	500.4	531.3	-10.2	1321.9
1983	268.8	478.9	463.7	-67.7	1143.6
1984	253.2	480.0	490.8	78.5	1302.5
1985	210.0	392.5	530.9	52.9	1186.4
1986	124.6	313.0	247.4	158.1	843.0
1987	64.6	174.3	249.6	-73.1	415.4
1988	58.9	127.9	204.0	97.6	488.4
1989	51.7	124.8	250.9	-56.2	371.2
1990	74.6	201.9	307.6	129.8	713.9

* at 1988 prices.

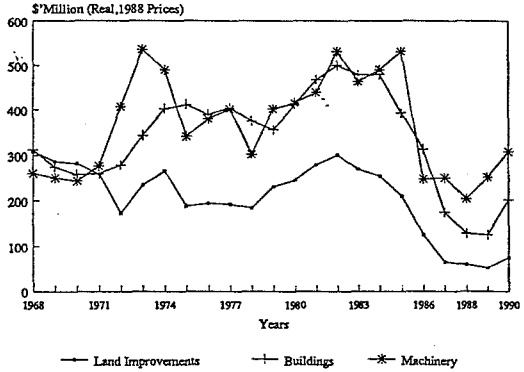
The driving objective of this new methodology was to obtain a new estimate of the real rate of depreciation on the assets used in the farm industry. Since base year data was available for 1966/67 and 1987/88, the resulting estimate of depreciation strictly refers to the intervening years only. In Johnson (1970) the real depreciation calculation was carried out for the period 1946-1967. To recapitulate, the base year stocks were valued at replacement cost at nominal prices and then converted to real prices using the Statistics Department index. For livestock a comparision is also made with comparative unit prices. The increment of new capital added in gross terms was derived from the Statistics Department capital expenditure series and deflated by the Department's capital expenditure price index. Depreciation or wastage (D_t) was derived by subtracting the 1988 stock of capital (K_{88}) from the sum of the 1967 stock of capital (K_{67}) and the additions of new stocks of capital (GI).

$$D_t = K_{67} + GI - K_{88} \quad \ldots\ldots\ldots\ldots\ldots\ldots \text{ Equation 1}$$

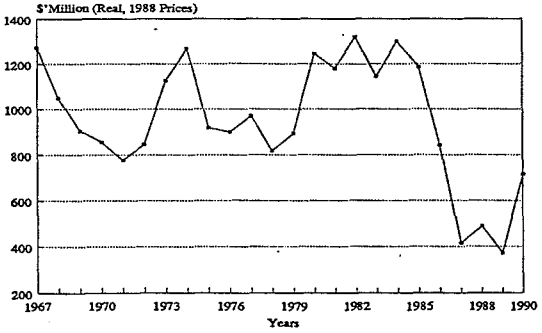
This equation was used to derive the results presented in tables 4 and 5.

Gross Annual Investment in Stock of Capital: Table 1 shows the data on real gross annual investment for the period 1966/67 to 1989/90 and Graph 1 shows the investment trends for land improvements, buildings and machinery, over this period. Graph 2 shows the aggregate level of real annual investment in farming for the same period. It is clear that there were two periods of high re-investment in the early 1970s and in the early 1980s. The middle to late 1980s are characterised by high dis-investment. Since livestock investment is measured as the change in inventory this component is subject to the vagaries of the census question and the payment of incentives on a per head basis in some years.

Graph 1: Annual Gross Investment in Stock of Capital



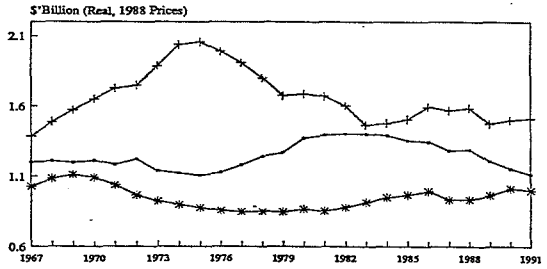
Graph 2: Aggregate Gross Annual Investment in Stock of Capital*



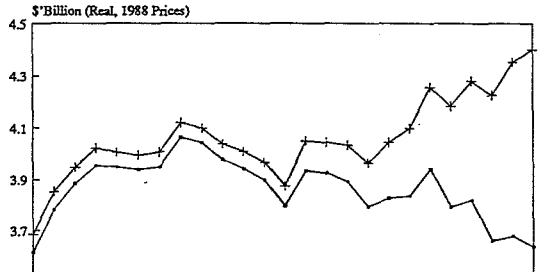
* Total of gross annual investments in land improvements, buildings, plant and machinery and livestock.

Livestock Assets: Graphs 3 and 4 show trends in the composition of the livestock inventory over the period 1967 to 1991. In Graph 3 the build-up of beef stocks in the early 1970s is shown and the smaller build-up in sheep in the late 1970s. In Graph 4 the total of sheep and beef and dairy valuation is shown and demonstrates the decline in the traditional pastoral sector from the middle 1970s. When goats, pigs and deer are included in the aggregate valuation of all livestock, as in Graph 4, it shows that the real capital stock in livestock is maintained through the 1980s.

Graph 3: Value of Total Livestock

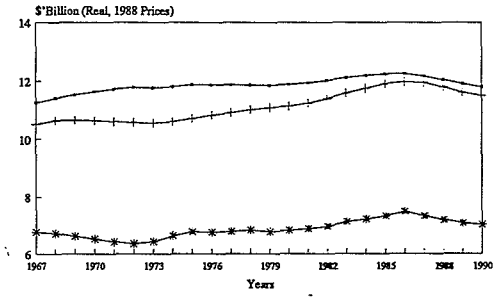


Graph 4: Value of Total Livestock

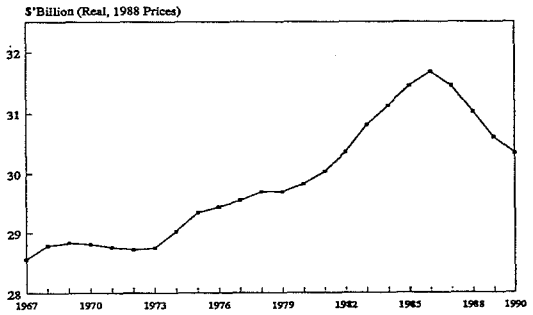


Stock of Capital: Graph 5 shows the stocks of land improvements, buildings and machinery and Graph 6 shows these stocks in aggregate. Now it is clear that there has been a steady build-up of the three components in the 1970s reaching a peak in the mid 1980s and then starting to decline. The peak season was 1985/86. Since 1985/86 the value of total stock of capital has been declining at a faster rate than the annual investments. Up to the 1984/85 year, the Government policy was to encourage investment in farming and this is what happened.

Graph 5: Total Stock of Land Improvements, Buildings and Plant and Machinery

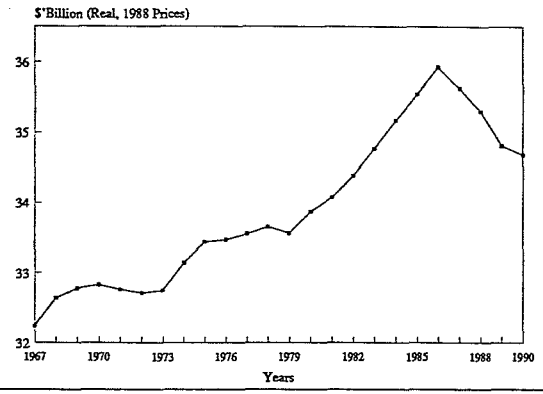


Graph 6: Value of Aggregate Stock of Capital, Excluding Livestock*



Although the total value of livestock continued an upward trend, as shown in Graph 4, the value of aggregate stock of capital, including livestock, continued the downward trend since 1986. This is shown in Graph 7.

Graph 7: Value of Aggregate Stock of Capital, Including Livestock



After 1985, the Government's policy was to let farming find its own level of production and investment in relation to prices received and paid and initially at least this resulted in a lower level of capital investment than had ever occurred in the past. It is also clear that incomes were depressed and the capacity to borrow was severely restricted through this period.

Table 2 shows the base year valuations of the total stock of capital at nominal and real prices using the replacement cost method. The total stock of capital in 1988 was worth $35.3 billion in 1988 prices. This was producing output of $7.4 billion and GDP of $3.5 billion all at 1988 prices. The 1967 stock of capital was worth $34.4 billion at 1988 prices. If livestock are valued at unit prices of the 1987/88 season the value of the total stock of capital drops to $32 billion. Details of the reason for this are discussed in the annex to the paper.

Table 2: Value of Capital Stock in New Zealand Agriculture, Valued at Replacement Cost of New

	Nominal 1988 Prices	Real 1988 Prices	Nominal 1967 Prices	Real 1988 Prices	Real 1988 Prices, Except Livestock Valued Using Actual 1988 Market Prices
	1988 Inventory $'m	1988 Inventory $'m	1967 Inventory $'m	1967 Inventory $'m	1967 Inventory $'m
Land	12,039	12,039	1,345	11,264	11,264
Buildings	11,795	11,795	1,011	10,520	10,520
Plant/Mach	7,192	7,192	783	6,769	6,769
Livestock	4,279	4,279	1,113	5,835	3,685
Total	35,306	35,306	4,252	34,388	32,238

When capital stocks are valued at depreciated stock as in the perpetual inventory method, the real value of the total stock of capital is somewhat lower. This is shown in Table 3. At 1988 prices the 1988 stock of capital was valued at $26.8 billion and the 1967 stock of capital was valued at $26.5 billion. It should be noted that the land improvement component and the livestock component are valued at replacement cost in both Tables 2 and 3. If 1988 unit values are used for livestock the 1967 stock of capital at 1988 prices is valued at $24.4 billion. For buildings in 1988 the depreciated cost is 68.8 percent of replacement cost; for machinery in 1988 the depreciated cost is 33 percent of replacement cost.

Table 3: Value of Capital Stock In New Zealand Agriculture, Valued at Market Value of the Asset

	Nominal 1988 Prices	Real 1988 Prices	Nominal 1967 Prices	Real 1988 Prices	Real 1988 Prices, Except Livestock Valued Using Actual 1988 Market Value
	1988 Inventory $'m	1988 Inventory $'m	1967 Inventory $'m	1967 Inventory $'m	1967 Inventory $'m
Land	12,039	12,039	1,345	11,264	11,264
Buildings	8,114	8,114	693	7,214	7,214
Plant/Mach	2,373	2,373	258	2,234	2,234
Livestock	4,279	4,279	1,113	5,835	3,685
Total	26,805	26,805	3,410	26,547	24,397

Wastage Effect: The methodology employed concentrates on the "wastage" or "decay" factor in the stock of capital accumulated in the farm sector. Table 4 shows the calculation of the annual rate of asset wastage when the stock is valued at replacement cost. As might be expected the wastage of plant and machinery is highest and exceeds in amount the value at the beginning of the period by a factor of 1.10. That of buildings is 0.58 and land improvements is 0.34. On an annual basis the rate of wastage for land improvements is 1.65 percent, on building 2.76 percent, and for plant and machinery 5.25 percent. Over the whole stock of capital the average rate of wastage is 2.90 percent. Livestock is not included in these calculations as the wastage factor is incorporated in the annual death losses; this can be derived if needed.

Table 4: Wastage Rate of Agricultural Assets, When Stocks Are Valued at Replacement Price of New

	Land Improvements	Buildings	Plant & Machinery	Total* Stock
Gross Investment 1967-1988, $'m	4595.4	7402.7	7856.3	19854.4
Value of Stock, in 1988, $'m	12038.7	11795.3	7192.3	31026.3
Value of Stock, in 1967, $'m	11264.5	10520.3	6768.5	28553.3
Asset Wastage,** 1967-1988, $'m	3821.2	6127.7	7432.5	17381.4
Average Annual Rate of Asset Wastage, 1967-1988 %	1.65	2.76	5.25	2.90

* Land Improvements plus Buildings plus Plant and Machinery, excludes livestock.

** See equation 1.

Table 5 shows the calculation of the annual rate of asset wastage when the stock of capital is valued at depreciated cost. The only new results here are for buildings and plant and machinery. Now the amount of wastage is much higher as the stock is valued much lower. The factor for plant and machinery as a ratio of beginning value is 3.46 and that for buildings is 0.90. The annual rates of wastage are 16.36 percent and 4.26 percent respectively. The overall rate of wastage is 4.12 percent.

Table 5: Wastage Rate of Agricultural Assets, When Stocks Are Valued at Market Value of Asset in Use

	Land Improvements	Buildings	Plant & Machinery	Total* Stock
Gross Investment 1967-1988, $'m	4595.4	7402.7	7856.3	19854.4
Value of Stock, in 1988, $'m	12038.7	8113.8	2373.5	22525.9
Value of Stock, in 1967, $'m	11264.5	7214.0	2233.6	20712.1
Asset Wastage,** 1967-1988, $'m	3821.2	6503.0	7716.5	18040.6
Average Annual Rate of Asset Wastage, 1967-1988 %	1.65	4.26	16.36	4.12

* Land Improvements plus Buildings plus Plant and Machinery, excludes livestock.
** See equation 1.

In Johnson (1970) the rates of wastage for the period 1946 to 1967 were around one percent for land improvements and 8.9 percent for plant and machinery.

This methodology is not that perfect but it does give some corroboration to the rate of depreciation used by the Inland Revenue Department in the case of the depreciated cost of stocks of capital in Table 5. The depreciation rates used by the Inland Revenue Department are presented in Table 6.

Table 6: Depreciation Rates Allowed by the Inland Revenue Department, 1992

Item	Depreciation Rate (%)	Method of Calculation*
Buildings - reinforced concrete	1.0	Cost Price
Buildings - brick, stone, concrete	2.0	Cost Price
Buildings - wood	2.5	Cost Price
Motor Vehicles	20.0	Diminishing Value
Plant	10.0	Diminishing Value
Office Equipment	20.0	Diminishing Value

* Depreciation is calculated either as a fixed percentage of the cost price of the asset, or as a fixed percentage of the diminishing book value of the asset.

Up to 1992 development expenditure had to be capitalised and depreciated at certain rates, as shown in Table 7:

Table 7: Depreciation Rates on Land Improvement Expenses Allowed by the Inland Revenue Department, 1992

Item	Depreciation Rate (%)
Eradication of Pests	5.0
Felling of Trees and Stumps	5.0
Destruction of Weeds	5.0
Construction of Fences	10.0
Erection of Power Lines	10.0

The present estimates are clearly drawn from the same population as the Inland Revenue Department rates. Goodness knows what the basis is of the actual rates used by Inland Revenue Department!

CONCLUSION

We feel that this investigation has been worthwhile in promoting the understanding of the underlying production function for the farm sector. This set of estimates is a distinct improvement over the last set published way back in 1970. The methodology has been improved and more attention paid to the definition of gross capital stock.

The user should still be aware however that the gross capital stock method is not a substitute for the market value or depreciated cost method. It does not fully take account of any decline in the productivity of existing stock of capital.

In the case of land improvements, all estimates are for land improvements and no account is taken of unimproved value.

The depreciated cost method is based on book values as found in the Meat and Wool Boards' Economic Service data, and is not an estimate of market value per se.

Further work needs to be carried out on a comparision of depreciated cost valuation of the farm asset and market valuation of the farm asset. This has not been attempted here.

Users of the data back to 1946 can obtain a consistent series, at constant prices, from the authors on request.

With this set of estimates now available on a consistent basis the way is clear to carry out further studies. Some of these studies are already under-way at MAF Policy and others are being planned. Among these are:

- the role of the service price of capital;
- the economic determinants of investment;
- the aggregate production function;
- aggregate productivity of resources employed;
- re-estimation of the Laing-Zwart model.

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1 Valuing Livestock: Comparison of Methods

		$m
Value of Livestock in 1988	(Nominal)	4,279
Value of Livestock in 1988	(Real)	4,279
Value of Livestock in 1967	(Nominal)	1,113
Value of Livestock in 1967	(Actual 1988 Prices)	5,835
Value of Livestock in 1967	(1967 Prices inflated to 1988 Using PPI - Output)	3,685
Value of Livestock in 1967	(1967 Prices inflated to 1988 Using a GAP based index)	5,395

It seems Producers Price Index (PPI) - Output may not be the appropriate index to use. Using actual 1988 prices to value 1967 stock in real terms seems more appropriate as it reflects change in numbers only. When a Gross Agricultural Production (GAP) based index is used, the total value of livestock is closer to the $5,835 million value than $3,685 million.

2 Data on Inventory of Stock of Capital

Inventory of stock, including livestock, are reported in Agricultural Statistics. The last complete survey for plants and machinery was done in June 1986. They are assumed to have remained unchanged for the 1988 year. No further complete survey has been done since 1986.

Some of 1967 data on stock of capital was taken from Johnson (1970), and later verified with Statistics Department data.

3 Data on Replacement Cost

Data on cost of replacement of capital stock items were mainly from Financial Budget Manual, published annually by the Lincoln University. Information on forestry came from a private consultant, while those on horticultural crops came from MAF Tech horticultural consultants.

4 Data on Market Value of Assets

Data on the age structure of land improvements will probably never be collected. Thus, it was assumed that the market value of land improvements would be equivalent to its replacement cost. This is a valid assumption, since many of the land improvement items used in farm production need to be well maintained to keep in production. The value of such item should almost be

equivalent to its replacement cost. The rate of "wastage" of land improvements given in Table 4 is also very low.

In the case of market value of farm buildings, Meat and Wool Boards' Economic Service data is most reliable. Around early 1970s they used to have 3 categories: capital value, farm buildings and homestead. Now, they have combined farm buildings with capital value. Using the early 1970s ratio of farm buildings to capital value, value of farm buildings can be extracted from capital value where they are combined. Value of buildings, including homestead, worked out to be approximately 70 percent of the price of new asset. Thus, all buildings were valued at 70 percent of the price of new buildings. Ninety percent of total New Zealand farms less idle properties and plantations were assumed to have a homestead and farm buildings.

For plant and machinery, it was again assumed that 90 percent of the properties (less those in plantations and lying idle) had plant and machinery. Considering a shorter average life of plant and machinery compared to buildings and land improvements, it was assumed that the market value of plant and machinery items were 33 percent of their replacement cost. This was based on a decay rate of 15 percent over a life of 10 years. The values estimated were later verified with the Economic Service data.

C-2 RESOURCE MANAGEMENT

THE RESOURCE MANAGEMENT ACT AND PROPERTY RIGHTS

by R.W.M.Johnson

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This paper explores the application of property rights to sustainable land management objectives. Property rights are briefly defined and discussed in terms of their characteristics including the principles of attenuation and efficiency. Their relationship to the Resource Management Act is then discussed in the context of its sustainability objectives. The future development of suitable regulations and incentives is assessed from a property rights point of view.

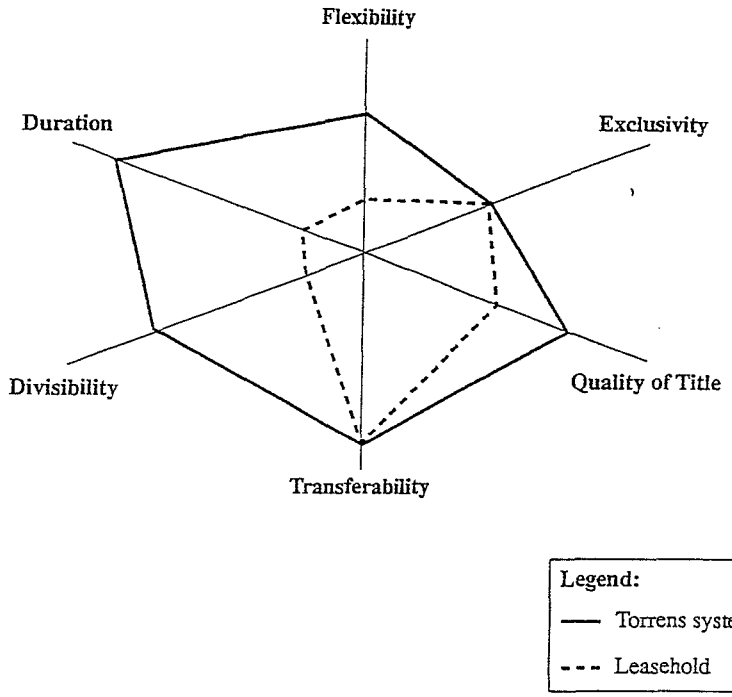
Introduction

The chosen system for achieving changes in farm management practice in terms of soil conservation objectives has been to offer a system of incentive payments to land holders targeted on needed conservation objectives. These incentives recognised the strong bargaining position of the landholders both politically and legally. Their political power stemmed form their dominance in the early legislatures while their legal power stemmed from the system of land registration first introduced by Torrens in South Australia. The thrust of the argument to be presented here is that the Torrens system was too successful in achieving its primary objective of title security and lacked the flexibility to be adaptable to needed changes in practice when these became necessary in the pursuit of wider environmental goals.

This paper first discusses the nature of property rights with specific reference to land holding and defines what is regarded as an efficient set of property rights. Reference is made to how water and mineral rights relate to these attributes. The paper then goes on to examine a proposition that a re-distribution of land property rights toward social ownership would be an alternative method of reaching needed land management standards at considerably less cost to the exchequer. This proposal is compared with other polluter pays proposals for meeting conservation goals. The paper concludes by assessing how practical these propositions are and whether they are technically achievable.

Figure 1: Six Characteristics of Interest in Real Property

(after Scott, 1989)



Comparison of Tenure Systems:

Characteristic	Torrens System	Leasehold
	(Scores on a scale 0 - 100)	
Duration	100	20
Divisibility	80	20
Transferability	100	100
Quality	100	80
Exclusivity	50	50
Flexibility	80	20

Property Rights

Property rights are a set of behavioural rules that society chooses to observe and accomodate to. Dragun (1989) refers to "the social pattern of rights and duties". They can be established through custom, convention or law (Hide 1987). The essential fact is that they are observed rather than sanctified by law alone. In land holding such rules specify who may use a resource and how the resource may be used. Such rules allow exchange to take place with some security and therefore assist in allocating resources among competing interests. The market works precisely because it is backed up by a set of property rights.

Exchange of property rights is based on their exclusivity and transferability. An exclusive property right is the ownership of a car; a common property right is the right to use the roads. One is exclusive and transferable and the other is not. The right to exclude, says Hide, is a pre-condition to the right to trade. An exchange permits a value to be established and hence establishes a market for property rights. Exclusive property rights must be specified and policed, and contracts for the exchange of rights must be negotiated and enforced.

There are at least six characteristics of property rights that qualify their usefulness in economic exchanges (Scott 1989). A recent reference is Young (1992) who discusses sustainable investment and resource use from a similiar point of view. Figure 1 shows a diagrammatic representation of these six characteristics of interest in rights which are based on the following descriptors:

Duration: length of time an arrangement holds for; a period in which a rightholder can profitably invest in harvesting (Scott); durability and security (Young).

Flexibility: discretion to change use; ability to adapt to change; what can and cannot be done without consulting others.

Exclusivity: the strength of a right; the inverse of the number of persons who must be contacted to internalise enterprises like fishing (Scott); freedom from disturbance; strength of acceptance by the community; exclusive entitlement to profit (Young).

Quality of Title: legal protection and security provided by common law and things like registration systems; acceptance of title by others; political stability, right to compensation, right of first refusal of any new set of rights (Young).

Transferability: ability to transfer to others; number of parties to whom a transfer can be made (Scott); movement to more equitable and more ecologically appropriate locations, combinations and uses (Young).

Divisibility/Assemblability: ability to sub-divide; ability to aggregate; ability to share; ability to have joint holders

(Scott); ability to assist transferability (Scott); usefulness of small bundles (Young).

Scott then says the amount of each characteristic in a standard interest can usefully be regarded as observable, measurable and continuously variable. For example, each may be scored from 0 - 100. This classification is intended to replace terms such as "incomplete", "imperfect", "attenuated", or "property-ness". Furthermore, these characteristics can be regarded as a sixpointed star-shaped figure formed by joining its measured points on the six characteristics axes. This is what is shown in Figure 1.

It is possible to use such a diagram to compare two systems of land rights. In Figure 1 a freehold system of land tenure is compared with a leasehold system. The right to occupy land is well understood in New Zealand. Fairly arbitary scoring on the 0 - 100 scale has been used for this example. But in general freehold systems of land tenure are very high on most attributes other than exclusivity (there is not a lot of protection from the actions of others) while leasehold tenure scores weakly except on transferibility and quality of title. The resulting linkages between characteristics in the diagram thus form "pictures" of different property right systems. Young (p.110) maintains that a continous lease or licence framework is a promising way of achieving environmental security through roll-over and compensation clauses.

An alternative formulation to Scott's characteristics can be developed through the concept of attenuation (Quiggin 1986). Any limitation on the way in which property rights may be used constitutes attenuation. The ideal, unattenuated state is approximated by private chattel ownership where the owner has completely free rights of use, exclusion of all others and complete alienation. The attenuation of property rights, in this view, will always reduce their value to the owner, and is sometimes viewed as undesirable(ie by the followers of Coase). This is particularly true when attenuation is the result of actions of governments, such as regulatory limits on the way in which property may be used or restrictions on the sale and purchase of property. The key features of non-attenuation are complete specification of the right, exclusive specification, full transferibility and enforcibility (Dragun 1989).

However, as Jacobsen (1991) points out, the ownership conferred by property rights does not normally entail the right to impose costs on others. Rights are attentuated by the state to prevent adverse consequences to others, and in turn protect owners from the actions of others. For further discussion of the philosophical origins of these terms see Alchian and Demsetz (1973), Castle (1978), Quiggin (1986), Izac, (1986), Cox, Lowe and Winter (1988), and Dragun (1989) among others.

An *efficient* set of property rights refers to minimising the costs of making changes to right holdings, the costs of policing and the costs of establishment (eg registration). Hide (1987)

gives an analysis of transaction costs and their relation to efficiency. Young (1992, p 112) also recognises the role of cost-effective administration. The Torrens system of land registration is a very efficient set of property rights because it provides high security at low registration cost, it requires low policing costs and changes can be made at small cost and easy convenience. Litigation raises the costs of many exchanges of land rights and hence can be seen as a counter to transaction efficiency. Poor design in legislation could be one reason for this. Thus an efficient set of property rights is a well designed set, widely trusted by the people involved and not subject to vexatious litigation. Conflict does arise, however, and the courts may be the only way to resolve difficulties between conflicting interests.

There is some conflict in the literature with this definition of efficiency. Bradsen (1988) for example does not distinguish between project costs and transaction costs and hence never really defines what economists would call an efficient system. Jacobsen (1991) discusses social cost-benefit analyses incorporating the depreciation of natural capital as a cost. Subsequent discussion indicates that Jacobsen includes transaction costs, such as "high costs of public ownership", within her definition of social cost.

There are thus two efficiency goals to consider. Attenuation of property rights may be required to achieve a social optimum in a resource use problem area where externalities are present. This would include, for example, developing institutions which recognised the appropriate shadow prices and facilitated socially optimal solutions. Secondly, efficient use of property rights as an institution can be achieved by good legislative design and appeal systems. This latter objective necessarily includes the regional or local government bodies which will *administer* the legislation.

Property Rights in Land

We have well-developed and efficient sets of property rights for land. Freehold title is generally regarded as more secure than leasehold title.The system is so well designed that it provides full security at low cost, has low policing costs and provides a high degree of protection. The market for land operates without any doubt as to the authenticity of the title or the potential risks.

The right of ownership then confers on the owner further rights as to how he/she might use that right. They may prevent trespass, they can choose any land use they like, they can erect a building and they can sell any product from that land without encumbrance. ("Use" is defined in the town planning sense rather than a farming sense). Titles can have attachments to them such as the registration of debt secured against that title. In Western Australia, notices to occupiers of land from the commissioner of soil conservation can be registered with the appropriate land registrar (Looney 1991). Some attachments lower the exchange

value of a right but at the same time inform the players in the market and therefore raise efficiency.

Security of a right is generally associated with a greater commitment to long term care of the land. Figure 1 explains this difference from the point of view of the various characteristics of interest in a right. Against this we need to consider Young's view that leasehold tenure may have the potential to adjust to changing circumstances.

The rights of use have become constrained by social controls in a number of instances. The Town and Country Planning Acts and mineral legislation, for example, constrain building rights, subdivision and access typically. They do not constrain the selling of the product, however, though cases of this do occur (see indigenous forest discussion below for example).

In the historical context, these property rights facilitated the opening up of the land. They provided an incentive to develop and enabled the developer to capture all the gains from occupation. They also secured the owner a reward when development finished as the right was immediately transferable to others at a market determined price backed by the very system of which it was part.

In the longer run, it was inevitable that some of the (social) costs of development of the land were not captured in the market process. In particular, deterioration in surface cover, soil loss, sediment transmission, and water quality loss can still occur within the Torrens system of land registration, which was otherwise so efficient in achieving its purposes. The conditions of use of the right allowed these things to happen and no sanctions were introduced to prevent them happening for a long period. The position was potentially worse where leasehold land was concerned (Kirby and Blyth 1987).

When changes (in externalities) take place or new ones are recognised, the system of property rights is no longer efficient and efficacious. A new system of property rights is needed to reflect societal values which at the same time minimise transaction costs. The Resource Management Act epitomises the new set of social values and indicates that both regulatory and market based measures may be used to reach the Act's objectives. Such legislation must be scrutinised very carefully from the property right point of view just because new solutions and the consequential legal provisions could potentially be very expensive or vexatious to introduce or bring about.

In economic terms the Torrens system does not deal well with environmental externalities. Soil erosion, seepage, and water contamination are the long term impacts of the human use of land which affect others than the right holder. They occur as a result of the inability to negotiate and enforce an exchange of the relevant property rights (Hide 1987). The inability arises because physical or technical factors prevent the parties getting together or they simply went unobserved. They are typically non-point sources of degradation.

In the case of waterborne sediment, the downstream owner's rights are not protected; there is no market in "rights to cause soil loss" and transfer the costs; there is no point discharge on which to fix a levy; solutions up to the present have been based on incentives to degraders to stop or control the relevant practice. One solution is to bring the degraders and the recipients together in a common rating system and spread the costs of treatment; in this way the externality can be internalised.

Legislation like the Resource Management Act can be viewed as an exercise in the redistribution of property rights. Legislation places restrictions on the use of resources governed by property rights and hence can potentially change land use itself. An attempt to change access rights for mining exploration is discussed below.

The scope of such legislation is also governed by property rights. By scope, is meant all those persons and corporates who may be affected by the provisions. Control over resources means control over the users of resources. The users are already in occupation and have established formal and informal rights. The domain of such legislation is defined as being all property held under some system of rights whether it be freehold land (registered title) or some other right conferred by custom, agreement or contract. Thus there is no reason why good practice standards should not be introduced for leasehold land as well as freehold land.

Property rights are important in land precisely because they enable social control over resource use and management (Hide 1987). Through reform and adaptation, the use and management of resources is improved. In adapting property rights, society adjusts the respective roles of the state and the individual and explores the ability of political and market mechanisms to manage the resource stock better to reach the desired social optimum.

Water Rights

Water rights are an example where social considerations often outweigh the desires of the individual. Riparian rights derived from prior access have given way to appropriation doctrines that consider water a public resource held in trust by the Crown (OECD 1987). Permits or licences are used to allocate the resource thus substituting administrative procedure and/or legal covenants for a market in single use rights. Current criticism is based on the imperfections of such administrative systems as they do not adequately provide for recreation, conservation and spiritual values, do not provide for other water uses, and do not provide an efficient set of rights (Moore and Arthur-Worsop 1989).

This viewpoint maintains that a system of well-defined and tradeable property rights would be more socially advantageous than administered systems. They could provide greater flexibility and security, better information on resource values, minimal transaction costs and the ability to accomodate new resource

values (Hide 1987). Flexibility comes from being able to allocate water in accord with demand and changing use values. Security is gained by actual ownership of the right, as opposed to Crown ownership. The allocation process has the potential to be more transparent as resource values will emerge through bidding among alternative users. In a well-defined statutory environment information regarding transfer arrangements and possibilities is more transparent thus limiting uncertainty and ultimately transaction costs. These conclusions are consistent with a movement towards non-attenuated rights as defined earlier.

Administrative systems hide or disguise transaction costs. From an economic point of view achieving an *efficient* set of water property rights should be the target of public policy. A market for water rights creates opportunities for new uses to be recognised at relatively low cost. It would probably *not* provide for all recreation, conservation and spiritual values unless the respective lobbies were forced to "buy" their requirements. However, investigating, assessing and verifying all claims to a water source (not to mention appeals and legal proceedings) remains a high transaction cost process. Therefore legislative solutions in water rights must be particularly well-designed to achieve the potential efficiencies that are possible.

It has been pointed out that water markets will not perform perfectly (OECD 1987, Ch 2). Market based allocations may not recognise the proper social accounting (or shadow) prices. In a multiple resource use situation, some uses will be difficult to identify and measure, and the mix of private and public goods will greatly complicate the design of an efficient property rights system. The presence of some public good aspects in the solution will always lead to some under-statement of demand.

Under the Resource Management Act, we are in a position to move to a system of transferable water permits. The responsibility for implementing them will fall on regional councils who will establish the regulatory and allocative framework for granting in-stream rights. Further analysis is obviously needed of these institutions to ascertain the *relative* efficiency of different allocation systems.

Other Rights

In this section access and product disposal rights are discussed. Under New Zealand mining legislation the surface owner has a right of veto over access on certain classes of land only. These classes include land under some horticultural use, land in urban areas, land under burial grounds, airstrips, waterworks, roads, bridges or buildings, and all conservation land. The remainder is open to access (for exploration) without consent of the owner and makes up most of the pastoral farmland and exotic forest estate. For information on other mineral property rights see Jardine and Scobie (1990).

In the Resource Management Bill, it was proposed that land owners should have a veto over prospecting, exporation and mining on *all*

land. In the past the mining rights had over-ridden the occupation rights. The proposed veto changed the distribution of property rights and hence the incentive to invest and develop. Such a veto would discriminate against the Crown as a mineral and petroleum owner in favour of the landholder. It would also reduce the incentive to explore for minerals and raise the transaction costs of getting access. This would reduce the efficiency of the set of property rights held by the explorers. It would transfer windfall gains from the former owners of rights(the explorers) to the new owners(the surface owners) and could result in a lower rate of mineral exploration and hence affect the over-all development of the economy.

This is case of the *relative* efficiency of two right systems. From the point of view of the landholder he is interested in getting rid of (mining) rights that have priority over the ones he holds. From the point of view of the explorer, and indeed of the nation, the *status quo* was all about enabling society to have it both ways; one use of the land can continue to be developed while the potential to use it for something else is not forgone. Environmentalists had sided with the landholders in the debate as they wanted greater impediments to mining development as an absolute goal. In the event the *status quo* was preserved in the Crown Minerals Act and further testing and analysis of the relative merits of the two systems of property rights was passed over.

The disposal of product derived from the possession of a right is exhibited by the regulations prohibiting the felling of indigenous trees for export purposes. The regulations were part of an attempt to conserve the native forest estate as well as trying to conform to international standards of behaviour with respect to the felling of indigenous forests.

The ban on exports effectively used an administrative decree to limit the harvest of trees on private land. The regulations prevented landholders from felling timber for export purposes without compensation. Thus the surface owners interest in the land was made subservient to the public interest.

From the landholders point of view here was an arbitary decision to limit the sources of his income. It appeared there were cases where the exploitation of this resource was essential to the continued viability of the individual enterprise. Subsequent negotiations recogised this fact and a form of compensation was agreed to. The new government elected in 1990 has since put the forest regulations on hold.

From the environmental point of view it was regarded as imperative that New Zealand made an international gesture as early as possible.

From an efficiency point of view, the proposal was disadvantageous for the land right holder. The plan would have involved the preparation of a sustainable harvest plan approved by the Ministry of Forestry. The costs of this plan, especially

if it involves survey costs, could make this option non-operable for many smaller freehold areas of forest. Some discussion was also based on the introduction of a felling fee to discourage use of the private forest estate. In all these cases the transaction costs of the conservation goal would have been high.

Sustainability

The Resource Management Act is effectively a change in the social paradigm that directs land and water resource use. The concept of sustainability lies at the centre of the Act's provisions. In the Act sustainability is defined as "..managing the use, development, and protection of natural and physical resources in a way, or at a rate, which enables people and communities to provide for their social, economic and cultural wellbeing and for their health and safety while:

> a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations; and
>
> b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and
>
> c) avoiding, remedying, or mitigating any adverse effects of activities on the environment".

The Soil and Water Conservation Act was passed in 1941 and the Town and Country Planning Act in 1948. These Acts have gradually introduced definitions of what could be called "good" land and water use and provided mechanisms for national and local government to pursue such goals. The legislative provisions impose restriction on the holders of land rights and represent reductions (or attenuations) in the earlier property rights granted to them, bought by them, or inherited by them.

In general, the cooperation of landholders (in soil conservation particularly) has been gained by a system of incentives for changes in management practices. As earlier mentioned, common law rights to water were abolished by the Water and Soil Act 1977 and control shifted to the State. Subdivision, changes in use (including buildings), and peri-urban development were all "licensed" under the town and country planning regulations. In the new Act, local government will be responsible for amending or continuing the ordinances which will have higher standards to meet than in the past.

In broad terms the experience in soil conservation has only been partially successful. There would be some sympathy for the view that "Australia's departure in the 30s and 40s from the Australian way of dealing with land management problems, such as pest plants, animals and insects, to rely on the US voluntary, awareness, education, approach to land degradation can perhaps be excused,.....It has not been effective and continued reliance on this approach cannot be excused. The commitment of substantial community funds compounds the error, especially in

the absence of accountability according to proper land conservation standards" (Bradsen 1989, p 11).

Without using property rights language, Bradsen is in favour of strong attenuation of land use rights to eliminate externalities and meet desired standards. He recommends compulsory property plans incorporating sustainability principles. This would be backed up by some system of enforcement, including the power of aquisition, an appeal system, and provision for formal reports and periodic reviews. Landholders should, for a period of adjustment, *not* be required to meet all costs on a polluter pays basis; considerable sums of Commonwealth finance will be required.

Thus Bradsen's emphasis is on compliance and standards and the means to best achieve these. There is no accounting of transaction costs of the alternatives. It is essentially goal driven. This example is useful as it provides the extreme case in the following discussion of less attenuated systems for achieving the same objectives.

Incentives

Over a considerable area of land conservation, and particularly for soil conservation, systems of cash incentives have been used to encourage good land management practices. This system of subsidies and concessions is necessary, say Bromley and Hodge (1990), to counter-balance the existing set of property rights. They see the state becoming more and more involved with technological externalities of existing land use practices as the state represents the section of society affected by the unwanted effects of agricultural land use. The state's response has been either to introduce some form of regulation in which specific quantitative goals will be set, or a set of financial inducements to obtain compliance from the agricultural community. The process is accompanied by extensive political negotiations in either case. In effect, say Bromley and Hodge, the presumed property rights in land become translated through the political process, into presumptive entitlements in the policy area (see also Cox, Lowe and Winter 1988).

But such arrangements need not be fixed in concrete; "The presumption of an absolute right to produce food and fibre creates an open-ended agricultural policy in which the state - and its treasury - has become the captive of the sancity of private rights in land, the political power of the farmers, and the technological prowess of modern agriculture. If farmers are on a technological treadmill, the industrial state is surely on a fiscal treadmill. The generally secure position which landowners enjoy, however, has no immutable legitimacy - though its political legitimacy is another matter. Institutional arrangements are social creations, fashioned to serve collective objectives"(Bromley and Hodge 1990, p 212).

Bromley and Hodge propose an alternative approach. They suggest that the state defines a desirable system of land use compatible

with environmental objectives, and that existing practices be measured against this desirable system. "The desired level of countryside and community attributes would be determined through collective action at the local level, but with wider oversight if the domain of concern transcended the locality"(p 202). A plan for a particular area would specify the constraints over land use required to achieve the desired level of environmental quality. Farmers would remain free to choose enterprises and methods of production so long as the final result does not violate the plan. In effect, the property rights which formerly resided with the farmer are transferred to the collective entity.

To make the system flexible, it is suggested that the farmer be given a right to deviate from the plan by paying into the public purse. This represents a turnaround of the incentive system where the farmers bribe the state rather than the state bribing the farmers. It is a variation of the polluter pays principle. The deviation from the standard would presumably lead to greater private income from that permitted and hence would be a source of the payments that would flow to the state. The farmer would have to weigh up the alternatives. If instituted, such a system would reverse the direction of payments from the traditional pattern.

The authors discuss the administration of such a system of property rights. A considerable administration would be required in terms of specifying the appropriate constraints for the various regions of a country, and in systems for assuring compliance. The mix of environmental objectives could be quite wide and complex and would differ for different regions. In our case, a new set of goals and standards would need to be evolved. Point sources would be easier to accomodate than non-point sources. A considerable scientific input would be required (though there are similarities here to Bradsen's approach). Current legislation would have to be re-drafted to meet the holistic systems approach put forward.

The proposed system would bring about a realignment of all the incentives to produce. Policy instruments that give financial incentives to farmers would disappear. Production levels would be governed by the system of permits which allowed deviations from the ideal (Bromley and Hodge assume that the ideal is not at the top of the production possibility curve). Generally, output would be most modified where farming systems were heavily dependant on sensitive environmental inputs.

The costs of production would be higher (except in the case of zero use of enviromental inputs if such could be found). Costs would increase either to meet the new standards or in bribing the authorities to get departures. Output positions would depend on the particular effect of each environmental constraint. It seems plausible that the costs of meeting the standards would depress the value of the land right and hence land values; the higher the standards are set above practice the lower the resulting land value.

Finally, agricultural producers would come to be regarded as land managers rather than producers. If increased costs drive up market prices for products, then consumers would be paying a tax for product produced in an environmentally sound way. This would be an estimate of the social cost of current agricultural practice. If the complete system were to be accepted and to be instituted successfully, the environmental externalities of existing agricultural systems would have been internalised.

In terms of current land tenure systems the proposal seems a very large step into the future. There are various practical problems which are discussed below. However, Bromley and Hodge remind us that nothing is immutable; "It is important to recognise that the current assignment of of entitlements in land - and, by extension, in the policy arena - are simply artefacts of previous scarcities and priorities, and of the location of influence in the political process. To assume that these entitlements are necessarily pertinent and socially advantageous to the future is unwarranted. Shifting values and changing perceptions of the role of agriculture will surely bring about at least marginal shifts in property rights and policy entitlements"(Bromley and Hodge 1990, p 212).

Institutional Requirements

The above discussion demonstrates that any system of reform of property rights will require considerable adjustment of land holding institutions. The basic premise is that existing property right systems do not protect the rights of others. These latter rights are typically related to environmental concerns including water.

Water is characteristic in that it *transfers* a problem from one point to another and hence *beyond* the immediate concern of the polluter. Control needs to be exerted on the actions of the polluter to achieve standards which society deems desirable. Thus costs could be imposed on farmers to reduce pollution of waterways, and benefits in the form of clean water would be generated for society as a whole.

Under the Resource Management Act, local authorities are required to define outcomes that meet the purposes of the Act. Most important of these are the clauses requiring minimum standards of environmental protection (sub-clause b of the purposes clause). In some cases, society may have a view of absolute purity, ie no material in their drinking water whatsoever. The costs of achieviving this are normally met collectively.

To meet the required standard economic instruments could be used by the managing authority to achieve it. Polluters could be taxed for pollution above the bottom line or they could be required to pay for transferable permits, or possibly required to negotiate with affected community groups and compensate them for some agreed standards. Repetto (1980) assesses the relative merits of price and quantity-based instruments where the slope of the MC curve indicates whether to use a price or a quantity instrument.

From an economic point of view, the market process is clearly preferable. From the social point of view, the cooperation of the community would be preferable. It would be second best for the local administering authority to assume the role of setting standards though they may be highly tempted to do so.

Think of a free-draining catchment with excessive use of fertiliser. A solution might be to establish a market in fertiliser inputs (Reeve and Kaine 1991). A set of traded permits in phosphorus use could be devised which did not *exceed* the absorptive capacity of the waterway and which could be adjusted to the total quantity of water available. In effect it would be a market in phosphate discharges. The authors claim that such a system would:

- require minimal research and monitoring by the managing agency (once it was set up),
- improve the agronomic efficiency of nutrient use,
- provide incentives for private sector investment in monitoring of phosphate discharge,
- provide incentives for industries that *fix* stream water phosphates in biomass and export it from the catchment, and
- provide opportunities for conservationists to fund further improvements in water quality by purchasing and retiring permits.

Practicalities

There are a wide range of environmental objectives that need to be addressed. A system is needed that deals with soil erosion, surface cover, burning, water quality, water discharge, pesticide use, noxious weeds, introduced animals and pests, tillage on slopes, and so on. The incidence of these differ from region to region.

There is a great deal of scientific work required to establish environmental standards covering all the desired outcomes. However, it may be that good practice rules could be derived that substitute for scientific criteria. There are great differences between point sources of degradation and non-point sources.

Existing institutional measures use a variety of instruments. Regulations are used in some areas and incentives in others. Collective administrative systems conceal the costs of regulatory and incentive schemes and few comparisions have been made of the alternatives. It is not clear at this stage which of the "bads" would be best suited to a polluter pays scheme such as Bromley and Hodge propose. Reeve and Kaine have outlined how a market could be established for farming inputs which create waterway pollution.

Regional and district councils will have the responsibility of setting environmental standards subject to national policy directives. They will have an obligation to consider all possible instruments and justify their selection as the most efficient (section 32). Some uniformity would be assured by consultation with neighbouring jurisdictions.

As it stands therefore the mix of incentives and regulations is in the hands of the local authorities. A proposal like Bromley and Hodge's would require more direction from the centre than is currently the fashion in New Zealand.

Conclusion

The property rights analysis brings out the crucial role of market solutions to resource management problems. The attenuation of private property rights was found to be justified because spillovers or externalities are common in agriculture. Scott's representation of interest in property rights is a useful descriptive tool but should remain subservient to the need for social control of environmentally sensitive inputs.

Non-attenuated property rights still have a role in guiding efficient use of resources *within* a well-defined social and institutional framework.

The property rights efficiency analysis does provide some insight into the rights established under the Torrens system of land registration. No one has established before that there is a direct connection between land use practices and the characteristics of property rights. The Torrens system is very efficient in doing what it is meant to do - providing absolute security at low cost. The registration system was designed before the recognition of technological externalities and hence does not provide any incentives to right holders to manage the externalities properly.

There is little evidence of assessment of relative transaction costs of different right systems. Some of this would be undertaken in backroom dialogue when respective merits of alternative plans were thrashed out. This may have to change as the Resource Management Act (section 32) does require any objective, rule or policy to have regard to the benefits and costs of the principal alternative means and effectiveness in achieving the objective or policy. There will be scope here for considerable discussion of the relevance of transaction costs and efficient solutions.

The Bromley and Hodge proposal involves defining a satisfactory institutional framework and developing satisfactory standards of performance. They then introduce the notion of a non-tradable permit for a departure from the standards at a suitable fee. It is not clear whether the fee would be scaled according to the degree of the departure from the norm. In effect, the proposal is a polluter-pays solution *without* transferability.

Reeve and Kaine develop a transferable permit system for phosphate discharge into waterways with a scaled fee. The non-point discharge problem is overcome by *estimating* the external impact from fertiliser use. In a water basin, transferability is permissable because the total load of nutrients is the important parameter.

The latter proposal goes a long way to meeting the efficiency criteria laid down at the beginning of this paper. Individual initiative is retained by a relatively simple attenuation of an unfettered property right with fairly low transaction costs. Agronomic efficiency is enhanced and incentives created for investigating less polluting uses and management of fertiliser. Control of the nutrient load in waterways then brings about the desired social level of control of potential eutrophication and unsightly masses of stagnant water are not created.

In the end, the very complexity of the subject matter, and the relatively large number of interested parties who have to be consulted, will bring about new administrative systems which will be, at the very least, best effort approximations to the levels of optima described in this paper. Attention must focus on the administrative solutions that controlling authorities can devise that achieve environmental objectives while at the same time minimise the impact on efficiency and growth.

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"SOIL RESOURCE MANAGEMENT-THE INSTITUTIONAL AND REGULATORY FRAMEWORK"

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ABSTRACT

"The paper will consider the implications of the Resource Management Act and of the post-1984 reform of the public sector for management of New Zealand's soil resources. A recent policy initiative which has a soil conservation objective, will be considered. It may be that the use of subsidies to obtain desired resource outcomes should be debated more vigorously than in the past. Property rights issues will be discussed".

GENERAL STATEMENT OF THE "SOIL RESOURCE PROBLEM"

In considering the policy response to soil and water issues in New Zealand it is helpful to distinguish differences, in economic terms, between the two resources. Water is often quoted as an example of a "public good". The distinguishing features of a public good are the principles of "non-excludability" and "non-rivalrous consumption".

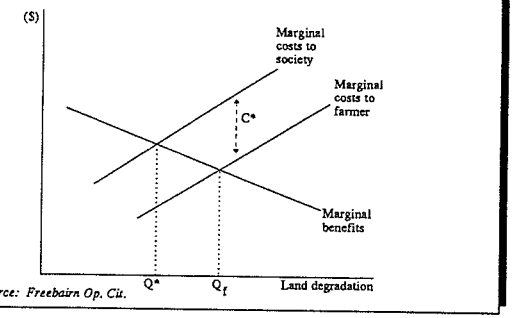
For some water uses, these principles can be demonstrated. For instance, if a city spends money on upgrading its water supply, those who would not willingly contribute to the costs can not be excluded from the benefits. At the margin, non-rivalrous consumption also exists. My consumption of clean water does not appreciably diminish the supply available for others.

However, water use can also be both "rivalrous" and "excludable". Farmers compete with other in-stream users for the use of water for irrigation purposes [rivalrous consumption]. Where water is piped or channelled, farmers who do not contribute to scheme costs, can be by-passed [excludability].

In considering **property rights**, the important difference between the two resources arises from the ability to exclude. The static and fixed nature of the land resource compares to the mobile and variable nature of the water resource. These differences are reflected in law. As a landowner, my property rights allow me to prevent you from making use of my land without my consent. However, a right to use water for whatever purpose, is normally reviewable and is subject to consideration of the needs of other users.

The views expressed in this paper are those of the author and not necessarily the views of MAF Policy.

Land Degradation with Significant Off-site Costs



Source: Freebairn Op. Cit.

As stock numbers are increased on erosion-prone hill country, stock performance can be expected to fall and land degradation to increase. The marginal benefit of land degradation will therefore decline as stock numbers increase.

Soil erosion in turn means a lower carrying capacity in future years and a reduced land valuation for degraded areas. Hence the upward sloping marginal cost curve shown in the figure. This curve represents the on-site or marginal costs facing the farmer.

Costs to society include the off-site costs as well as the on-site costs. At every level of land degradation, the costs to society exceed the costs faced by the farmer by the amount of the externalities, C*.

The optimum level of land degradation, or investment in soil conservation, occurs at the point where marginal benefits costs and social costs are equated. For the farmer, this is at the point Qf. For society, the optimum is Q*. The impact of taking externalities into account is therefore that, in general, national welfare is increased by inducing farmers to adopt practices which result in a lower level of land degradation than they would otherwise choose.

Note that the shape of the curves, indicating that the socially-optimum level of soil resource degradation is a positive number greater zero, is a judgement based on empirical evidence.

Virtually all pastoral and arable activity leads to some soil loss. Given the slow rate of soil formation in New Zealand, "sustainability" of soil resource use can be interpreted to mean a policy of zero soil loss. However such a policy is not necessarily economically optimal. Even the existence of a significant region-wide soil erosion problem does not necessarily indicate a mis-allocation of resources either by farmers or by society as a whole.

Environmental groups may well have some difficulty with this proposition. An interesting discussion of the economics of sustainability is contained in Fox, (1990). However the idea that there is a tradeoff between increasing investment in soil conservation and the marginal net benefit of that investment is not new to farmers,

or to regional governments charged with implementing soil conservation programmes.

THE COASE THEOREM

Policy makers, both in New Zealand and overseas, when faced with the externalities of land degradation, have tended to recommend Government intervention. In New Zealand, a key policy component has been subsidy to land owners to change land use/management, e.g. the subsidy paid to farmers for on-farm soil conservation work. However, the existence of externalities, per se, is a necessary but not sufficient condition for justifying any Government intervention at all.

The most quoted example used to illustrate the argument is that used by Coase (1960) - the wood-burning locomotive emitting sparks which set fire to farmers' corn fields. Rather than repeat Coase's example, a hypothetical New Zealand case is developed, based on, but simplifying, the Waitomo Caves situation.

Sediment build-up is threatening an underground cave tourist facility and the livelihood of tourism operators. The sediment results from farming activities upstream of the caves and could be much reduced by increased investment in on-farm soil conservation.

The property rights issue is whether the tourism operators have the right (say, under the Resource Management Act) to prevent the farmers from discharging sediment upstream of the caves. Coase's point is that, provided such property rights exist, it is possible to use market transactions to transfer and recombine them in such a way that the investment in soil conservation is socially optimal.

Assume that the courts rule that farming activities are infringing on the property rights of the tourism operators. Further that the total net cost to the farmers of reducing the sediment discharge, in terms of income forgone and the direct costs of the soil conservation measures required, exceeds the net benefit of that property right to the tourism operators. Then, according to Coase, the up-stream farmers will purchase the property right from the tourism operators [or otherwise compensate them for loss of income], and continue to discharge sediment as before.

The reverse situation is where the property right is worth more to the tourism operators than to the farmers. In that case farmers would find it cheaper to invest in soil conservation than to compensate the tourism operators.

The Coase theorem is that provided the market in property rights is allowed to function freely, the allocation of resources devoted to the soil conservation will be economically efficient regardless of the initial distribution of property rights. Further, that there is **no case for Government intervention.** The initial allocation of property rights is important only to the extent that it affects income distribution eg if the courts ruled that the farmers had the right to discharge sediment, the tourism operators would need to pay for **all of the cost** of the soil conservation investment if they were to continue in business.

Followers of Coase acknowledge that the theorem will fail if either **transaction costs are prohibitively high**, or, if **agents are few enough to act strategically.** The **transaction costs** in this example are all of costs associated with arriving at a **mutually satisfactory bargain** between the tourism operators and the farmers.

Coase largely ignores the possibility of **freeriders.** In the context of the example, some of the parties may not be willing to enter the bargaining process in the expectation that they, too, will benefit, if the others negotiate a successful outcome.

At first sight, the Coase theorem appears to be a new perspective on economic policy for public goods. However "the theorem is not fundamentally at odds with the more traditional view that intervention is only justified in the case of non-rival or non-excludable benefits. High transaction costs, which may prevent Coase-type bargaining from taking place, are also the basis for non-excludability" (Clough, pers. comm.)

The policy prescription suggested by the Coase theorem is in marked contrast to the approach of the former National Water and Soil Conservation Authority. Government intervention, by way of subsidy payable to the farmers, would have followed automatically once significant net benefits to society were proven.

PROPERTY RIGHTS ISSUES

One issue for New Zealand is the extent to which farmers should be liable for the off-site damage which results from their land use. A possible interpretation of the Resource Management Act is that it extends the scope of the law of nuisance by designating soil erosion as a nuisance[1]. The more general problem is the balance between the public good and the private property rights traditionally enjoyed by farmers.

A legal perspective on the general problem is that of Lord Denning who observed that where "the balance (is) too heavily in favour of the rights of property... government should rightly intervene .. so as to give public good its proper place".

Farming leaders appear to be relatively relaxed on the issue to date and there is acceptance that farmers' property rights do not permit unrestricted exploitation of the land. "Private interests related to earning a living from the land must remain private while public interests are a common responsibility and shared cost... In exchange for shared costs, landowners forego rights to act in ways that impinge on the wider public right" Prickett (1992).

Implicit in this view is that if Government wants a greater investment in soil conservation than farmers are prepared to make, then it must pay for it. There is an underlying presumption that the farmers' property rights admit no liability for the downstream effects of soil erosion. In the past, policy makers have tended to adopt an approach to soil erosion problems which has not economically disadvantaged farmers. However it is suggested that a legal challenge is possible under the

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1 Soil erosion was recognised as a nuisance in Sections 34 and 35 of the 1959 Amendment to the Soil Conservation and Rivers Control Act. However Catchment Boards did not make use of the powers available (Steel, pers. comm).

Resource Management Act and may well have been also possible under previous legislation. In the terminology of the Resource Management Act, should a **resource consent** be required for activities which result in soil erosion. Is the sediment resulting from soil erosion a **discharge** which requires consent under a **regional plan**? What is the difference between a farmer whose use of the land results in soil erosion and factory process which results in the discharge of waste into the waterways?

A key difference between a sediment discharge resulting from farm soil erosion and a factory process discharging waste is that, in New Zealand, soil erosion is typically **non-point** ie sediment in a waterway can not easily be traced back to the farm of origin. It may be that it is technically impossible to measure the contribution of each farm to the total sediment load in a catchment and therefore impossible to fairly apportion any externality costs back to the farmers concerned.

Factory wastes and even forestry logging operations tend to be **point discharges.** It is therefore easier to apportion any externality cost and the problem is more amenable to the use of either regulation or economic instruments to provide a solution.
Any response under the Resource Management Act is further complicated by the fact that pastoral farming in most if not all catchments is an **existing** rather than a **proposed** use.

Although there are clearly technical problems in assessing the extent to which individual farms are contributing to total sediment load in a catchment, this possibility should be further researched. Economic efficiency is improved if any part of the externalities, C*, can be internalised into farm decision-making.

THE LEGISLATIVE RESPONSE IN NEW ZEALAND

The key piece of current legislation is the **Resource Management Act**. An historical context is first developed by considering previous legislation.

The **Soil Conservation and Rivers Control Act 1941** was concerned with river protection, flood control and loss of soil by erosion. The **Resource Management Act** is concerned with all adverse effects on the environment and is a far more wide-ranging piece of legislation.

SOIL CONSERVATION AND RIVERS CONTROL ACT 1941

The short description is "an Act to make provision for the conservation of soil resources and for the prevention of damage by erosion, and to make better provision with respect to the protection of property from damage by floods."

The Act, which was passed in war time, recognised a need for collective action to achieve a goal of improved water and soil management ie that water and soil management problems may have considerable associated externalities.

The impetus for the Act built up over an extended period of time. The eventual trigger was disastrous flooding in the Esk Valley [1938] followed by further severe flooding in the Taranaki hill country.

De-afforestation of upper catchments was recognised as being a important contributing factor to the severity of the flooding.

In the South Island, there was an awareness of erosion and declining soil fertility on tussock lands.

The Act created the Soils Conservation and Rivers Control Council which later became the National Water and Soil Conservation Authority [NWASCA] and regional catchment boards.

The objects of NWASCA were the:

- promotion of soil conservation;
- prevention and mitigation of soil erosion;
- prevention of damage by floods;
- utilisation of lands in such a manner as will tend towards the attainment of the objects aforesaid.

There was the power to create **soil conservation reserves**, to fence off, plant, or retire land.

Authorities could enter into **land improvement agreements** with landowners and covenants could be recorded against the land title [section 30]. Where grant moneys had been advanced, this section of the Act could be used to ensure, among other things, the replanting of forests after logging, if permanent forest cover was required for soil conservation reasons.

Catchment Boards were created and granted the power to rate. Land was classified to provide a basis for rating. Typically all ratepayers contributed to general operations by means of a "general rate". Where beneficiaries for specific works/schemes could be identified, special rating districts were formed with classification according to the benefit received.

Boards could also borrow, enter into contracts, and into cost sharing arrangements with landowners.

Afforestation was provided for under Section 134

The 1959 Amendment to the Act established **Section 34** which was commonly used by Catchment Boards to achieve soil conservation objectives. This section authorised boards to issue a public notice requiring prior consent for activities "likely to facilitate soil erosion...". The power has been used to control land clearance and earth works on hill country vulnerable to erosion.

WATER AND SOIL CONSERVATION ACT 1967

The short description is "an act to promote a national policy in respect of natural water, and to make better provision for the conservation, allocation, use, and quality of natural water, and for promoting soil conservation and preventing damage by flood and erosion, and for promoting and controlling multiple uses of natural water and the drainage of land, and for ensuring that adequate account is taken of the needs of primary and secondary industry, [community water supplies, all forms of water-based recreation, fisheries, and wildlife habitats, and of the preservation and protection of the wild, scenic, and other natural characteristics of rivers, streams, and lakes]."

The 1960's were a period of expansion for pastoral farming. Demand for water both for agricultural and non-agricultural purposes was increasing. The economic problem of allocation of scarce resources needed to be addressed. Water quality issues were also recognised in the legislation for the first time. Although soil conservation is mentioned in the short description of the Act, it is primarily concerned with water allocation issues and is not considered further in this paper.

RESOURCE MANAGEMENT ACT 1991

The short description of the [RMA] Act is that it "will restate and reform the law relating to the use of land, air, and water".

The process of public sector reform initiated by the 1984 Labour Government led to the dis-establishment of the Ministry of Works and Development and its agencies including NWASCA. Some NWASCA functions went to the Ministry for the Environment following the passing of the Environment Act 1986. Greater autonomy was given to the Catchment Boards which eventually became part of regional government. Grant money for catchment board activities was channelled through the Ministry for the Environment.

The Act reflects increasing concern, both within New Zealand and internationally, with a perceived deterioration of the environment in a holistic sense and with the sustainability of resource use.

Although the bill was developed post Cyclone Bola [1988], this event was not an influence on politicians in the same way that the Esk flooding was important in the lead-up to the 1941 SC&RC Act. In fact, although there was heated discussion on provisions for the use of some non-renewable resources e.g. minerals, soil resource issues were not raised in the parliamentary debate. Mineral resources were ultimately excluded from the Bill.

The resource management law reform process in respect of soil resources could be viewed as a streamlining of existing laws, making them more consistent by bringing them together, and by providing a new purpose. There seems to have been little interest in expanding the scope of the existing law. The result has been essentially a repositioning of the provisions of the 1941 Act to fit a new administrative structure.

The RMA sets out a hierarchical system of policy statements and plans. It is the **regional plans** which are important for soil resource issues. Regional plans are required to be consistent with any **national policy statements**. Landscape values, including peri-urban zoning are included in the **district plans**. These latter issues could also be seen as soil resource issues.

However the focus is clearly on the regional policy statements and plans. Regional Councils can control the use of the land for soil conservation [section 30]. Regional plans may encompass soil resource restoration/enhancement and control any use of the land which has the potential for adverse effects on soil conservation or water quality [section 65].

The meaning of the term "effect" in relation to soil is wide-ranging. Potential and cumulative effects can be considered as well as immediate effects [section 3]. The overall purpose of the Act [section 5] is to promote sustainable management of natural and physical resources. This section of the Act goes on to define "sustainable management". However, the term may eventually require interpretation by the Courts. One of the important sanctions of the Act is contained in section 9.

No person may use the land in ways which contravene rules in [regional or district] plans unless expressly allowed by a **resource consent.** Certain existing uses are protected by section 10. However insofar as the regional plans are concerned that protection is only temporary. Once a regional plan becomes operative, a resource consent must be applied for within six months. The Act allows for enforcement provisions where rules/plans are contravened.

Section 85 states that there is no compensation for restrictions placed on land. However, persons can apply to the Planning Tribunal to modify or delete such provisions in plans which "renders any land incapable of reasonable use, and places an unfair and unreasonable burden... Reasonable use is use or potential use which does not have significant effects on people or the environment".

A criticism of the Act is that it **does not clarify where obligations and property rights lie in respect of soil resources.** The regional policy statements, which precede the regional plans, are required [among other things] to set out the significant resource management issues of a region and how they will be addressed [section 62]. However this provision is non-specific and there is **no compulsion on Regional Councils to address the property rights issues.**

A second criticism is that although the structure of the Act clearly delineates the division of responsibilities for soil conservation between local, regional and national government, **it provides no guidance on the question of who should pay.**[2] An ad hoc approach has developed which has resulted in inconsistent treatment between regions and between competing land uses.

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[2] Local government theory is not discussed in this paper. One line of argument is the Tiebout tradition, which suggests different tiers of government for different levels of externality, depending on the scale of externality and the extent to which it transcends jurisdictional boundaries. (Rubinfeld, 1983)

THE FORESTRY LAND USE OPTION

The present delimitation of property rights, in favour of pastoral farming, is clearly important in considering soil erosion in New Zealand. The externalities associated with forestry could be expected to be different to those associated with pastoral farming. It must be accepted that, in general, forestry offers rather better soil erosion outcomes. For example, "...[on Taranaki hill country]..., about one third of hill slopes under pasture had at least 5% of their area eroded but less than 5% of hill slopes under forestry had the same level [of erosion]" Trustrum et al (1992). It may also be that there are important physical scale effects in considering the impact of afforestation on soil erosion at a catchment level.

Although it has been argued that a Pinus Radiata monoculture will lead to an irreversible depletion of the soil, conventional opinion is that the important potential negative environmental effects of plantation forestry are those associated with roading, logging and log processing.

Government has recently announced the East Coast Forestry Scheme, which has as soil conservation as one of its objectives. Forestry companies/others are being asked to bid for a subsidy to establish forests on land which is eroding under pastoral use. On at least some of the area eligible under the scheme, investment in farm soil conservation measures could provide an equivalent soil erosion outcome. The scheme therefore tends to distort landowners' choice of land use options.

The economic model developed in the earlier part of this paper considers the impact of externalities on society's choices for investment in farm soil conservation. Some modification of the model is necessary to consider impact of externalities on society's choices for investment in forestry in order to take account of time. However, the conclusion that the significant externalities are likely to exist for the forestry land use and that policies aimed at lowering the rate of land degradation, can produce net welfare gains for society, is likely to still hold.

There has been, as yet, no explicit evaluation of the externalities associated with either the present [pastoral] or the proposed [forestry] land use.

Regional councils, generally, have indicated an intention to use the Resource Management Act to limit any soil erosion which may be associated with forestry roading and logging.

It therefore appears possible that the Resource Management Act will be used to control the externalities arising from the forestry land use whereas externalities from pastoral land use will remain unaddressed. On at least some land categories, forestry and [pastoral] farming are competing land uses. Selective application of the Act is likely to further distort land use decision-making.

Any analytical framework to consider policies to promote land use change needs to consider the land use options both in total and at the margin. Dealing with the actions which have harmful effects is not simply a matter of restraining farmers from certain management practices nor minimising the cost to the Crown of changing the predominant land use. The fundamental economic question is how does the net value of product, including externalities, yielded by the proposed new land use and social arrangements compare to the status quo. The insights provided by Coase suggest that if indeed there are gains in economic welfare to be made from a change in land use, the role for Government might be to facilitate a "mutually satisfactory bargain" between the parties rather than to intervene by way of subsidy or regulation. One of the questions for policy makers to consider is the extent to which the mutually satisfactory bargain is being prevented by high transaction costs.

CONCLUSIONS

Policies designed to improve the sustainability of soil resource use must first show gains in net economic welfare. If such gains are shown, one of the issues is an equitable allocation of cost between landowners, ratepayers and the taxpayer. In examining this issue, the question of the property rights of the existing landowners should not remain unaddressed. The effect of doing so may be to unnecessarily transfer cost to the taxpayer.

Significant resource issues are now being examined with minimal reference to the Resource Management Act. Uncertainty on how the provisions of the Act can or should be applied exists at all levels of Government. Critical matters of interpretation have yet to be referred to the Courts. An ad hoc approach to resource issues is developing which is likely to result in inconsistent treatment between regions and between competing land uses.

The importance of Coase to current economic approaches to resource problems must be kept in perspective. The Coase theorem is only one of a number of factors which result in the broad thrust for limiting intervention. Other factors include concern with continuing large budget deficits and high levels of taxation. Interventionist policies in the resource area are therefore likely to be more critically examined than in the past.

Rather than accepting the proposition that Government intervention is justified in order to achieve sustainable land management objectives, economists should be reluctant to generalise. The policy analysis focus should be on any externalities or transaction costs which indicate that a market allocation of resources is sub-optimal.

As was recognised by Frank H Knight... " problems of welfare economics must ultimately dissolve into a study of aesthetics and morals". It is a difficult task indeed, for Agriculture to argue that land uses which can be attacked as "unsustainable", are in fact rational choices for society. However where policy options can offer equivalent environmental outcomes, resource legislation should not distort choices for landusers.

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THE DISCOUNT RATE

One of the key analytical problems in comparing any forestry proposal with [pastoral] farming is the choice of the discount rate. Forestry in New Zealand typically involves a 25-30 year rotation length. If the discount rate chosen is,say, 5%, it can be shown that **virtually all** New Zealand hill country would be more profitably used for forestry. On the other hand, King (1989) shows that forestry proposals **will not show a positive NPV at the 10% discount rate**, from the landowner's viewpoint even though the existing pastoral land use is acknowledged as unsustainable. King's valuation of the externalities indicates that the land use change is also uneconomic from the point of view of society as a whole.

Many in the environmental movement argue that farmers are excessively preoccupied with current period returns and downplay the longer term costs of their use of the land. In other words they argue that the discount rate implicitly used by farmers is too high and the result is unacceptably high rates of land degradation.

Kula (1988) advances an interesting argument that where significant inter-generational transfers of wealth [resources] are involved, the net present value criterion does indeed discriminate against future generations. The model which he develops for public sector investment in long rotation [50yrs+] forestry in the UK could also be used to analyse public sector investment decisions for soil resource conservation projects in New Zealand.

WATER QUALITY AND THE RESOURCE MANAGEMENT ACT: WHAT'S THE BOTTOM LINE?

by Jim Sinner[1]
MAF Policy, Wellington

ABSTRACT

This paper gives an economic interpretation of provisions of the Resource Management Act 1991 dealing with water quality. The paper examines how an economic perspective of pollution control fits with the RMA. "Setting the bottom line" is seen to be insufficient to maximise social benefits from natural resources. The paper concludes that resource managers should attempt to balance costs and benefits of pollution control in order to achieve the greatest net benefits for the community. Some suggestions are made as to contributions economists can make to this process.

AGRICULTURAL IMPACTS ON WATER QUALITY

There is a large body of literature in New Zealand regarding agricultural impacts on water quality, largely consisting of technical descriptions of site-specific situations. In addition, MAF surveyed regional councils in June 1991 to get their assessment of impacts on water quality.

In the survey, regional officials ranked agriculture as causing the most damage to water quality of nine major sources, especially when the effects of agricultural processing were included (Sinner, 1991).

Of nine major agricultural impacts on water quality, regional resource managers identified sedimentation and nutrient loading of surface water bodies as the most serious. Changes to physical characteristics of surface waters and faecal contamination of surface waters were ranked as slightly less serious impacts, followed closely by nitrate contamination of groundwater.

THE RESOURCE MANAGEMENT ACT

The Resource Management Act 1991 ("RMA", or "the Act") gives broad powers to central and local government bodies to maintain and enhance water quality. The Act builds upon the Water and Soil Conservation Act 1967, which it repealed, and restricts any discharge into water that would have significant or conspicuous effects on water quality. The interpretation of "significant" and other key words by local authorities and the Planning Tribunal will play a pivotal role in implementation of the Act.

[1] The views expressed in this paper are those of the author and not necessarily the views of MAF Policy.

Discharge of Contaminants

A key provision of the Act, section 15(1), prohibits the discharge of contaminants into water unless the discharge is expressly allowed by a regional plan, a resource consent (ie permit), or regulations. Discharge on land carries the same restriction if the contaminants might enter water.

Since a contaminant is defined as anything that is likely to change the physical, chemical, or biological condition of water, "discharge" of fertilisers or manure without permission into water, or where they might enter water, could be considered a violation of the Act. Under a strict interpretation, practices which cause sediment to enter waterways could also be considered violations, although these issues are more likely to be addressed under the soil conservation and land use provisions of the Act.

There is little doubt that discharge of effluent from a dairy shed, and any application of fertiliser or pesticide which results in significant amounts of nutrients or chemicals entering waterways would all be violations of the Act unless the land user has a permit from the regional council. Alternatively, regional plans might expressly allow these activities without requiring permits.

Under the Act, there is a presumption that any land use is allowed unless it is specifically restricted in a regional plan. One interpretation would be that, unless specifically restricted, land use practices would be "permitted" even if they result in sediment, nutrients, or faecal matter entering water. In other words, these forms of contamination may not be considered "discharges to water" covered by section 15, but this is difficult to reconcile with the definitions of "discharge" and "contaminant."

In any event, sections 70 and 107 of the Act state that **regional councils cannot issue plans or permits allowing discharges that are likely, after reasonable mixing, to result in any of the following effects in the receiving waters:**

(a) conspicuous oil or grease films, scums or foams, or floatable or suspended materials;

(b) any conspicuous change in colour or visual clarity;

(c) any emission of objectionable odour;

(d) making fresh water unsuitable for consumption by farm animals; or

(e) any significant adverse effects on aquatic life.

Maintaining water quality for human drinking or bathing is not required unless specified in a regional plan, but even so, only inconspicuous or insignificant effects are allowed. "Reasonable mixing" is not defined, but essentially allows for dilution of contaminants over some distance in the stream. The term has been interpreted by the courts under the Water and Soil Conservation Act 1967, but on a site-specific basis.

Also not clear from the context is whether change and adverse effects are measured from the current state or the natural state. While some parties might argue for comparison with the natural condition of a water body, this would be difficult to define in many instances. Measured against the current state, a significant change or

adverse effect would be any noticeable difference in the stream above and below the discharge. In other words, if contaminants were already present above the discharge, "effects" would be measured against that condition rather than the natural state. While this may be the only practical basis for determining effects, it is then not clear how regional councils can address the cumulative effects of agriculture and other activities on water quality.

The Ministry for the Environment has engaged technical consultants to develop recommendations to quantify and guide the application of these standards. The consultant has proposed to define "conspicuous" as change to an extent that would be detected by a large proportion of the population. The consultants have suggested that a 20% reduction in visual water clarity, measured by defined procedures, would meet this test (Davies-Colley 1991).

A conspicuous change in colour (or "hue") would be, for example, from green to blue-green or green-yellow. For very valuable water bodies in which hue is part of their scenic appeal (eg Lake Taupo) a more stringent guideline is advised, for example a maximum change from green to bluish-green.

To protect aquatic life, there is a proposed guideline that "euphotic depth" not be reduced by more than 10%. Euphotic depth is, in a general sense, a measure of the depth to which sufficient light can penetrate and still be useful for plant growth.

The proposed guidelines appear to relate to effluent sources where the natural state upstream can be compared to the affected state at the discharge site. It is not yet clear how the guidelines will relate to non-point sources, or whether there will be any attempt to define the "natural" state apart from that above the discharge.

Section 107(2) does allow a permit for discharge with some of these effects in "exceptional circumstances," or if the discharge is temporary, but in either case the exemption must be justified as consistent with the broad purposes of the Act.

It should be noted that under the Water and Soil Conservation Act 1967, now repealed, similar standards were set for catchments such as the Manawatu and Waikato Rivers. This is discussed further in Section 3.3 of this paper. Also, fertiliser runoff would have been classified as a "waste" under the 1967 Act, and any land user generating such runoff into waterways would have been in technical violation.

Under the 1967 Act, authorities either granted general authorisations for fertiliser applications or simply ignored the technical violations. The only way to regulate fertiliser use was through water rights, which is impractical for non-point source discharges. Given the right of private individuals to bring enforcement actions under the 1991 Act, and the ability of authorities to control land use to achieve water quality standards, councils may be less inclined to ignore violations.

Resource Consents

As indicated above, permission from regional councils is required to take water or discharge contaminants into water. This permission may be an individual resource consent, or a rule in a regional plan which classifies an activity as "permitted," subject to some conditions. This type of rule is similar to a "general authorization" under previous legislation, and in this case land users need no further permission for the permitted activity.

Alternatively, councils may classify activities as controlled, discretionary, or non-complying. All require resource consents from local authorities. Discretionary and non-complying activities require environmental impact assessments, and have an increasing presumption against the requested activity. Finally, councils may classify activities as prohibited, meaning applications for resource consents are not considered.

When issuing resource consents, regional councils will specify their duration. Under Section 128, consents can be reviewed before expiration under certain conditions, including the need to adjust permits to meet newly established water quality standards or minimum flows. When reviewing a consent, the authority must "have regard to whether the activity allowed by the consent will continue to be viable after the change" in the terms of the consent. This does not mean that making the activity non-viable is not allowed, but that this must be taken into consideration.

Section 36 allows local authorities to charge persons for resource consents, though a number of restrictions are imposed. In general, charges are only allowed for recovery of administrative costs, including monitoring, incurred by the council. However, section 108 allows local authorities to impose financial contributions, performance bonds, land covenants, and other requirements as conditions of resource consents.

Generally, discharge permits may be transferred to a subsequent owner of the same site, but they are not transferable from site to site. Permits to take water for irrigation or other purposes, on the other hand, may be transferred within a given catchment if such transfers are expressly allowed by the local authority.

For a variety of reasons, then, interested parties should seek clarification of discharge rules in regional plans. Activities which have little or no adverse environmental impact should be defined as permitted, with conditions clearly spelled out. This will be simpler and less costly for interested parties than permit applications for every proposed discharge.

Most importantly, if rules are spelled out in regional plans, everyone will have an opportunity to comment and will know precisely which activities or effects are permitted, which still require consents, and which are expressly prohibited. This should provide significant cost savings as fewer permit applications would need to be processed. Section 65(4) gives any person the right to request a regional council to prepare or change a plan with respect to any aspect of any function of the council, for the whole or part of the region.

Classification of Waters

Under previous legislation[2], now repealed, water quality standards could be established through a classification system, with different standards for different classes. Twenty-seven water bodies (including entire catchments and regions) were classified, including Lake Rotorua and the Kaituna River, the entire catchments of the Manawatu and Waikato Rivers, the waters of Southland, and other fresh and coastal waters (McBride and Davies-Colley, 1991). At a minimum, classified waters were subject to standards similar to those in Section 107 of the Resource Management Act. The existing classifications and associated standards now have the effect of regional rules under the RMA.

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[2] The Water and Soil Conservation Act 1967 and its predecessor, the Waters Pollution Act 1953.

Section 69 of the RMA allows regional councils to classify waters according to one or more uses listed in the Third Schedule of the Act. Each use has associated standards which must be observed, and regional councils have the authority to enact stricter or more specific standards.

Section 69(3) further states "subject to the need to allow for reasonable mixing of a discharged contaminant, a regional council shall not set standards in a plan which result, or may result, in a reduction in the quality of the waters" unless it consistent with the purpose of the Act to do so.

The purposes of the Act are found in section 5. Thus, under 69(3), the authorities would have to be satisfied that a reduction in water quality was necessary to enable people and communities to provide for their social, economic, and cultural well-being. The following conditions would also need to be met:

(a) sustaining the potential of natural and physical resources (excluding minerals) to meet the reasonably foreseeable needs of future generations;

(b) safeguarding the life-supporting capacity of air, water, soil, and ecosystems; and

(c) avoiding, remedying, or mitigating any adverse effects of activities on the environment.

Though this section provides some latitude to regional authorities, the restrictions in sections 70 and 107 still apply.

The Treaty of Waitangi

In addition to the purpose of the Act, section 6 requires all persons exercising powers and functions under the Act to recognise and provide for matters of national importance, including "the relationship of Maori and their culture and traditions with their ancestral lands, water, sites, waahi tapu, and other taonga." Moreover, section 8 requires authorities to "take into account the principles of the Treaty of Waitangi (Te Tiriti o Waitangi)."

It is not clear how these provisions will be given effect in practice, but there will be increased expectations of consultation with Maori by all authorities implementing the Act. Local authorities are likely, in turn, to require applicants for resource consents to consult with the tangata whenua.

Other Provisions

Several other provisions in the new Act are of interest. Section 43 allows the Governor-General, upon recommendation of the Minister for the Environment, to issue national environmental standards relating to, among other things, water quality. Thus, if the Minister were not satisfied with water quality standards implemented by regional councils, he or she could, after public consultation, recommend minimum national standards to the Governor-General. If promulgated as an Order-in-Council, these regulations would have the force of law.

The guidelines being developed for the Ministry for the Environment are not national standards. They are simply recommendations to local authorities. However, if the Minister believed it were necessary, he could recommend that the guidelines be converted to national standards after a process of public consultation.

Section 316 of the Act allows any person to seek an enforcement order from the Planning Tribunal to require another person to comply with the Act. Such orders may require a person to cease an action or to undertake certain actions in order to ensure compliance with the Act or to require a person to avoid, remedy, or mitigate adverse effects.

If a person is complying with a resource consent, the activity itself may be secure from enforcement actions unless incorrect information was supplied in the consent application. Under Section 314, however, the local authority's decision to grant the consent could be challenged. It is not clear whether an enforcement order could be granted requiring the authority to change or cancel the consent.

Section 13 restricts the use of lake and river beds, including the building of structures. Section 14 requires a person to have permission from the regional council to take, use, dam, or divert water of any kind. Taking reasonable amounts for an individual's domestic needs and drinking water for an individual's animals does not require permission, however, as long as there are no adverse effects on the environment. Taking of water for fire-fighting is also allowed.

Section 35 requires local authorities to "gather such information, and undertake or commission such research, as is necessary to carry out effectively its functions under this Act." The same section requires these authorities to monitor the state of the environment to the extent necessary to carry out their functions.

THE ECONOMICS OF WATER QUALITY

If strictly interpreted and enforced, the Resource Management Act 1991 would require land users to obtain permits from regional councils for agricultural activities that cause discharges into water, including agrichemicals, faecal material, and possibly soil particles. Permission could be in the form of individual consents or permissive rules in regional plans. In either case, the councils must be satisfied there are not likely to be significant or conspicuous adverse effects.

The Act has been interpreted as providing a "ecological bottom line" without reference to social or cultural factors. This raises the question of whether the Act will result in the best outcome for society. As economics is the study of the allocation of scarce resources, it is relevant to consider the question of water quality within this framework.

In economic jargon, pollution is a negative externality which leads to misallocation of resources because those causing pollution do not bear its full costs. If polluters were required to fully compensate all those affected by pollution, however, there would still be some pollution. In other words, full application of the "polluter pays" principle will not result in the elimination of pollution, nor is it intended to.

Given full opportunity to implement its collective will, society would probably not choose to abolish all pollution. This result stems from the fact that, at least in some cases, small levels of pollution cause little harm and can be quite expensive to eliminate. The question for policy makers, then, is what is the optimal level of pollution control? This question is relevant for agricultural as for other sources of water pollution.

Theory and Practice of Pollution Abatement

In economic terms, the problem is to determine the level of pollution control which maximises net benefits to society, where net benefits (NB) equal total benefits of pollution control (TB) minus total costs of control (TC), or

$$\text{maximise } NB = TB - TC$$

This problem is usually solved by choosing a level of pollution control where marginal cost (MC) equals marginal benefit (MB)[3]. In this context, MC is the additional cost to the producer of one more unit of pollution control. MB is the additional benefit to society of one more unit of pollution control, and includes cultural, social (including the needs of future generations), and intrinsic values as well as financial concerns. Most of these are difficult to quantify.

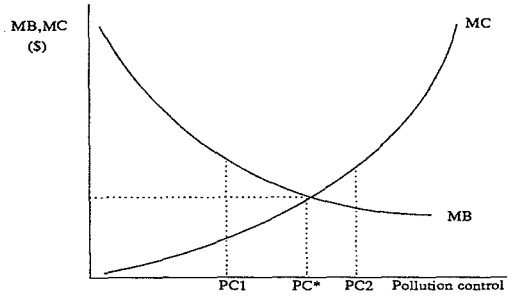

Figure 1: Marginal benefits and marginal costs of water quality

Economic analysis generally assumes the costs of controlling pollution increase as control increases. For example, to reduce pollution from 100 tonnes to 90 tonnes is assumed to be relatively cheap compared with the cost of reducing pollution from 10 tonnes to zero, which may be prohibitively expensive. This assumption is reflected in the MC curve in Figure 1, which shows that costs rise as the level of pollution control increases. Pollution control is not just "end-of-the-pipe" treatment; it also includes using less raw material, more efficient processing, and recycling and re-use of "wastes".

Similarly, it is generally assumed the marginal benefit of pollution control decreases as pollution control increases. That is, society derives more benefit from reducing pollution from 100 tonnes to 90 tonnes than from a reduction from 10 tonnes to zero. Thus, in Figure 1 the MB curve declines as the level of pollution control increases.

[3] For a discussion of the theory of optimal pollution control, see Randall, 1987.

Neither of these assumptions about increasing costs or decreasing benefits necessarily holds in the real world, as will be explained below.

Regardless of the shape of these curves, the optimal situation for society is typically where marginal benefit equals marginal cost. If MB is greater than MC, as at pollution control level PC_1, the benefits of pollution control exceed the costs, and the total welfare of society can be improved by increasing pollution control to PC*.

At control level PC_2, however, the cost of pollution control exceeds what it is worth to society, indicating more resources are being expended on pollution control technology than can be justified by the benefits. Only at PC* is there an optimal level of control, ie the marginal cost is equal to the marginal benefit of control, and net benefits are maximised.

In order to determine the optimal level of pollution control using this model, one needs to know the shape of the MC and MB curves, that is, how costs and benefits vary with the level of pollution control and the level of control at which costs and benefits are in balance. In practice, it is usually not possible to chart these curves precisely. Nonetheless, describing these curves in general terms should be of assistance in setting resource use policies.

As has been said, the marginal cost curve shows the additional cost to the producer of one more unit of pollution control. In other words, the curve shows the cost of applying pollution control technologies, that is, alternative management practices. Since the practices will vary depending on the nature of the problem, and sometimes with location as well, there will be a different marginal cost curve for each water quality problem and the associated alternative practices.

Typically, the MC curve will not be a simple smooth curve like that shown in Figure 1. Likewise, the marginal benefit curve, which reflects the value of clean water, and therefore pollution control, for other uses, is often not a smooth declining curve as shown in the figure. There are likely to be some instances where marginal benefits increase with more pollution control, and where the optimal level of pollution is zero. Nonetheless, the same principle applies: optimal resource use is achieved by maximising benefits to society, that is, setting marginal costs equal to marginal benefits.

A paper by Sinner (1991) provides further discussion of optimal water quality decisions, including how marginal costs and benefits are calculated and why the typical assumptions are often invalid. The paper also briefly discusses the use of economic instruments and regulation to achieve policy goals, and how intangible benefits can be incorporated into policy decisions. A study by O'Neil and Scrimgeour (1991) applies some of these concepts to the problem of dairy shed effluent.

The Legal Framework for Optimal Control

According to officials at the Ministry for the Environment, the Resource Management Act is not intended to direct regional authorities to calculate how to achieve maximum public welfare. Instead, these authorities should ensure certain outcomes are met and then allow private parties to pursue their own interests. Under this view, there would be no need for authorities to determine where marginal costs equal marginal benefits, ie the point of optimal pollution control.

Section 32 of the Act requires that both central and local government use the most efficient and effective means of achieving a given policy or objective. While section 32 does not require the policy or objective itself to be optimal in the sense described above, it does require that authorities shall be satisfied that any objective, policy, or rule is necessary to achieve the purposes of the Act. Regional council officials have also questioned the balancing of costs and benefits under the RMA, suggesting this is an outdated approach based on the Water and Soil Conservation Act 1967.

Yet because of the very nature of water quality problems, the balancing of costs and benefits cannot be avoided. By attempting to ensure certain outcomes, councils will typically constrain the actions of private parties. In other words, private benefits will be constrained to protect public benefits. This is as it should be, because water is a public resource, but the decision on how far to protect the public benefits should also take account of private costs and benefits. That is, councils should decide how much pollution control is optimal, ie what level would maximise total welfare.

This point can be demonstrated with an example using Figure 1, where the diagram represents a water quality problem to be addressed by a regional council.[4] The outcomes which the council must ensure, "the environmental bottom line," will require some level of pollution control. Consider the case where these outcomes require control only at PC_1, ie allowing more pollution than the optimal amount. Leaving private parties to pursue their own interests beyond this point will not result in the optimal level of control because the costs and benefits typically fall on different parties.

In this case, there are two ways to increase pollution control to the optimal result. One is for councils to use economic instruments to require private parties to bear the costs and benefits of their actions. For example, pollution above the bottom line could be taxed to encourage control at PC*, or polluters could be required to negotiate with affected community groups and compensate them for any agreement to allow pollution above the bottom line.

The second approach to move toward PC* is for councils to estimate the optimal level of control and set standards requiring that outcome to be achieved. Without active involvement by the council, however, either by setting higher standards or by establishing mechanisms for economic instruments, the optimal result will not be obtained.

Consider now the opposite case, where the outcomes the council must ensure, the "bottom line," require control greater than PC*, say at PC_2. In this situation, the point of optimal control will have been exceeded. Recall that the benefits include social, cultural and intrinsic values, though implicitly all these are based on human values. On the other hand, if very high or infinite benefits are attached to cultural and intrinsic values, the outcome at PC_2 may be desirable. This implies that the marginal benefit curve has been drawn incorrectly, and is higher, eg at MB' or MB'' in Figure 2, when all factors are taken into account. Sinner (1991) presented a methodology for incorporating intangible values into a decision framework based on benefits and costs.

[4] In this case, the assumption about the shape of the curves will not change the conclusions.

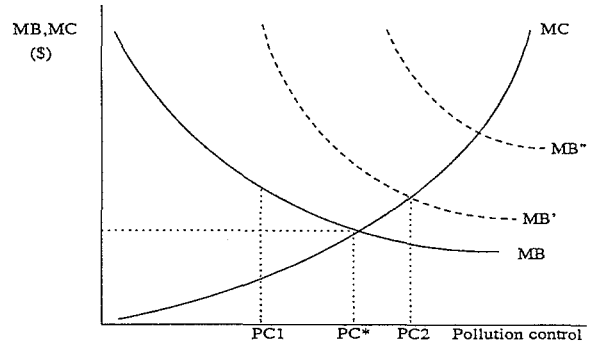

Figure 2: Optimal water quality with higher marginal benefits

Policy makers would need to consider the probable shape of the MB curve based on community values. If the original curve MB is considered the more likely shape, total public welfare could be increased by reducing the amount of pollution control to PC* and putting the extra resources to a more beneficial use. This might include spending more on environmental protection in another area of greater public concern, or it might mean assessing lower rates.

Although water allocation is a different issue than water quality, the same principle applies: in-stream flow should be at the level where the marginal costs of not taking an extra unit of water for abstractive uses are equal to the marginal benefits of the extra unit for in-stream uses. In terms of Figure 1, increasing pollution control is equivalent to increasing the in-stream flow.

It must be acknowledged that, in practice, this methodology will be difficult and expensive to apply in full. This is especially true if it were attempted on a site-specific basis, as it would be in an ideal world, since costs and benefits vary from one point on a stream to another. Nonetheless, as a framework, the principles of optimal control remain valid and should be applied in resource decisions. This means that in setting standards, officials should adopt the principle of balancing costs and benefits, even if these are not actually estimated, rather than only trying to set a "bottom line."

Any balancing of costs and benefits must be done within the context of the RMA and the definition of sustainable management. The needs of future generations, the life-supporting capacity of the natural environment, and the avoidance, remedying, or mitigation of adverse effects are all deemed to be of very high benefit to New Zealand by virtue of their establishment in statute.

With respect to water quality, the allowance for "reasonable mixing" may provide regional councils with sufficient flexibility to achieve optimal water quality as described above. In a situation where impacts on other uses of water are small, a longer mixing zone could be allowed as long as the purpose of the Act is not compromised. Conversely, where demand for clean water is high, a short mixing zone would be appropriate, ie the high marginal benefits would justify a higher degree of pollution control. Councils could use regional plans to indicate the degree of protection desired for different water bodies and the associated mixing zones that would be allowed.

Apart from the usual approach of setting standards and enforcing compliance, the use of "economic instruments" has also been advocated as a means of managing water quality. Such instruments, which can include pollution taxes, tradeable discharge permits, or tradeable extraction rights, can create powerful incentives for better environmental performance. In most cases, these instruments would be used in conjunction with regulations to achieve the best results. For instance, a council could set the minimum flow for a river, and then allow trading of water rights up to that level.

In a situation where pollution imposes costs before the "bottom line" is reached, a pollution tax can discourage the polluter from pushing up against the absolute standard. The tax forces the polluter to recognise that, although the standard has not been violated, the pollution does impose costs on society. Faced with paying a tax for every ton of contaminants, polluters will search for technologies which allow them to reduce the discharge, and will implement them if the cost is less than paying the tax.

Revenues generated can be used for other activities, such as monitoring and enforcement, which will further enhance water quality. It is not clear whether the RMA will allow councils to impose charges which exceed administrative costs. The Ministry for the Environment is considering providing some guidance to councils on this issue.

Tradeable permits can help lower the total cost of achieving environmental objectives. Again, this approach must be used in conjunction with regulatory standards. Once a local authority decides how much pollution in a water body is acceptable, it can allow polluters to negotiate among themselves how best to achieve the overall standard. However, tradeable discharge permits will only work where the location of the adverse effect is not important. It would not be appropriate, for instance, to allow a discharge on one stream to be doubled in exchange for eliminating another discharge on another stream in the same river catchment, if the impacts of the two discharges are not physically related. Probably for this reason, the Resource Management Act (section 137) does not allow discharge permits to be transferred from one site to another.

There are circumstances, however, where an authority may wish to encourage or allow holders of discharge permits, or those seeking permits, to negotiate about how much each will discharge. For instance, if there are two or more discharges close to each other, causing cumulative impacts, it would be appropriate to regulate the total effects, grant each polluter a consent to discharge an equal portion of the total, and then allow them to trade discharge rights among themselves.

There may be ways to facilitate some degree of negotiation within the parameters of the Resource Management Act, with regional councils playing a key role in approving any outcome. One possible mechanism would be for councils to buy back a discharge permit from a current consent holder and issue a consent for an equivalent discharge to another person on the condition that the council be reimbursed for the cost of compensating the original holder. Councils would not allow such transactions unless there were no adverse effects, and could choose to notify the proposed new consent application. Since original holders would only relinquish their permit if they agreed to the compensation, the new applicant could be required to negotiate this prior to applying for the new consent.

Under such a regime, polluters who find it costly to reduce emissions can purchase rights from others who can reduce emissions beyond what is required, as long as the overall goal is met. More importantly, all polluters will have a financial incentive to find ways to reduce emissions. This will drive innovation and generate better pollution control technologies, while achieving established environmental goals at the least cost to society.

Tradeable permits for taking water are already used in parts of central Otago, where they developed in conjunction with mining practices. Analysis is needed of the success of these permits at resolving water use conflicts, and whether they can be adapted to accommodate in-stream values. For instance, in addition to allowing in-stream users to purchase higher flows, those discharging contaminants may want to purchase higher flows at critical periods to maintain their normal dilution factors. Consideration must also be given to the principles of the Treaty of Waitangi and the fact that the Crown and local authorities cannot sell water they do not own. Permits would probably need to be limited to a fixed time period.

In many cases, using pollution taxes or tradeable permits will not be feasible, especially where discharges are difficult to measure. In other cases, however, they might usefully be combined with regulatory standards to achieve effective management of the water resource. More work will need to be done to examine the practical applications of these policy instruments.

CONCLUSION

Setting the "bottom line," and then leaving private parties to pursue their own interests, will not usually result in the optimal level of water quality. The ability of regional councils to determine "reasonable mixing" will perhaps provide the flexibility needed to realise the maximum net social benefit for society. In addition to setting and enforcing standards, there are other mechanisms which can be used to allow interested parties to negotiate between themselves to determine water quality parameters once the basic requirements of the Resource Management Act are met.

Economists can contribute to this process by estimating cost and benefit curves for improvements in water quality, and helping councils determine the standard of water quality that will maximise net social benefits. Economists can also assist in designing market mechanisms and other non-regulatory instruments that can be used by councils to bring private parties together to resolve water use conflicts.

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THE POSSUM PROBLEM: A CASE STUDY IN THE MANAWATU-WANGANUI REGION

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Summary

Possums were first introduced into New Zealand as a means of starting a fur trade over 150 years ago. Since their introduction, possum numbers have increased dramatically and the animal has become a major pest both in rural and urban areas. This study addresses the possum problem in the Manawatu-Wanganui region.

Presently control of possums is carried out by the Animal Health Board, Regional Council, Department of Conservation, households and a number of other smaller groups. An economic evaluation is required to decide whether or not the current level of control is efficient in relation to the benefits that the region derives from it. This was done via the contingent valuation method, using mail surveys.

Three major conclusions can be drawn from the study. First, there is a high level of awareness about the possum problem with 95.7 percent of respondents being aware that possums were causing problems in New Zealand. Second, the current level of expenditure in the region falls within the range of value indicated from the willingness to pay questions. Third, farmers valuations' of possum control were approximately twice that of nonfarmers, possibly reflecting the adverse effect that possums could have on their income stream.

Key Words: Nonmarket Valuation, Contingent Valuation Method, Possums.

1 INTRODUCTION

Possums were first introduced into New Zealand over 150 years ago to start a fur trade. Since then, they have spread to cover most of mainland New Zealand and a number of offshore islands. Controversy has surrounded possums since their introduction with Government playing a variety of roles in their control. This ranged from complete protection through legislation, to the funding of a bounty scheme to reduce possum numbers.

To assess whether or not the current allocation of funds for possum control in the Manawatu-Wanganui region is efficient in relation to the benefits derived from them, a study was carried out to measure the benefits gained from possum control. The Manawatu-Wanganui region is in the central to lower North Island and covers an area of 22,179 km^2 (Manawatu-Wanganui Regional Council, N.D.#1) or approximately 10 percent of New Zealand's total land area.

Although pest control carried out by the Manawatu-Wanganui Regional Council, Department of Conservation and the Animal Health Board in the region is projected to cost over $3.4 million for the 1992/93 financial year (Manawatu-Wanganui Regional Council, N.D.#2), little is known about the benefits that people from the region derive from it. Approximately 80 percent of this money will be spent on possum control. To this can be added the money spent by private households on possum control.

2 PROBLEMS ASSOCIATED WITH POSSUMS.

To understand the need for this research, one must first understand the problems associated with possums. These vary with factors such as locality, possum density and whether or not possums are serving as a reservoir for tuberculosis in that area. Those problems considered the most significant are damage to native forests and wildlife and the spread of the disease bovine tuberculosis. The major forms of possum damage in the Manawatu-Wanganui region are:

1 DAMAGE TO NATIVE FORESTS AND WILDLIFE- Possums are responsible for mass destruction of a number of tracts of indigenous forests. The severity of the destruction is dependent upon a number of factors including forest type and length of colonisation. For example, Batcheler, (1983) found that in the Pohingina Valley, high forest cover declined from 74 percent in 1946 to 6 percent in 1978.

2 SPREAD OF THE DISEASE BOVINE TUBERCULOSIS- Bovine tuberculosis was introduced into New Zealand with the first cattle importations. It was unknown in possum populations until the late 1960s when it was discovered in Westland. Since then it has spread rapidly throughout possum populations such that tuberculous possums now cover approximately 25 percent of New Zealand's land area. Tuberculosis is self sustaining in possum populations and is frequently spread from possums to deer and cattle. It is possible that in the future the level of tuberculosis in cattle herds could be used by Europe and North America as a trade barrier to the imports of a number of New Zealand animal products including beef, dairy products, live cattle and semen. It is estimated that the closure of access to the

North American beef market for one year could result in a loss of $484 million (Forbes, 1989).

3 DAMAGE TO EXOTIC FORESTS- Possum damage to exotic forests can be minimised as at thinning there is scope for reducing losses. Cowan (1991), however, estimated that with losses as low as 1 to 2 percent at rotation, an annual national loss of $7 million to $9 million would occur. Approximately 10 percent of New Zealand's exotic forest plantations are in the Manawatu-Wanganui region, thus regional losses in the vicinity of $0.7 million to $0.9 million could be expected.

4 DAMAGE TO PASTURE- Possums eat pasture to supplement their diet. Cowan (1991), estimated that even if losses were as low as 0.05 percent, in 1987 a reduction in export earnings of $12 million would have occurred.

5 DAMAGE TO CATCHMENT PROTECTION PLANTINGS- In some places whole protection areas have been rendered useless after possum destruction. Batcheler and Cowan (1988) estimated that possums cause between $300,000 and $800,000 worth to damage to catchment protection plantings each year.

6 OTHER DAMAGE- This includes damage to crops, loss of honey production, damage to buildings and the need for excluders on power lines.

Overall, Cowan (1991) estimated that the annual costs of possum control and damage are likely to exceed $35 million. Thus, possums are causing significant levels of damage in New Zealand. It was not possible to put a dollar value on the costs of possums to the region.

3 NONMARKET VALUATION OF POSSUM CONTROL

The estimation of the value that residents of the Manawatu-Wanganui region place on possum control is not straight forward as there are no markets to measure this value. Thus, a nonmarket valuation technique must be used to derive this value. The methodology chosen for this study was contingent valuation.

3.1 Contingent Valuation Method

This is a survey based method of eliciting the value that people place on a nonmarket good. With it, a hypothetical market is designed for the nonmarket good in question and people are asked to state how much they would be willing to pay for an increment in the good in question or how much they are willing to accept for a decrement in this good. The willingness to pay questions used in postal surveys commonly take one of two forms: the open ended question whereby respondents are asked to state the value they place on the good, and the dichotomous choice question whereby respondents are asked whether or not they would pay a given amount for the nonmarket good.

The open ended question can be analysed simply by aggregating the responses and calculating the mean or median value. With the dichotomous choice method, prices were varied between surveys, with the prices chosen to cover the expected range of bids. The logit model was then used to transform the responses (yes or no) to the bid prices into a function. From this it was possible to calculate the mean willingness to pay by integrating under the function.

The logit model may contain a number of variables based on economic theory and their influence on the probability of a respondent accepting the bid price. The parameter estimates for these should be theoretically consistent. For example, economic theory states that bid price coefficients should be negative and income coefficients should be positive. The model should also explain as much of the variation in the dependent variable as possible through the explanatory variables. That is, the goodness of fit statistic should be as high as possible. Rejection of variables should be based on a combination of the sign of the coefficients, the overall goodness of fit of the model and its ability to correctly predict outcomes.

4 SURVEY METHODOLOGY

To measure the value that residents of the region placed on possum control and the problems associated with possums in the region, a contingent valuation survey was carried out in June 1991.

4.1 The Sample

It was decided that the sampling unit should be households of the Manawatu-Wanganui region. Using households as the sampling unit meant that a larger percentage of the region could be covered by a smaller number of surveys. A random sample of households was selected off of the valuation indices for each District and City Council in the region. From this it was hoped to receive valid responses from approximately 1 percent of the region's households.

4.2 The Questionnaire

In total, 1652 survey forms were posted out. In two thirds of these, the willingness to pay question was in a dichotomous choice format, whilst in the other third of surveys an open ended question was used.

The questionnaire was accompanied by a covering letter describing the reasons for the survey and the area being surveyed. The survey contained a number of questions relating to the households' perceptions of the possum problem, the effects that possum were having on the respondents' properties, the households' willingness to pay for possum control and household demographic data.

The survey was posted out in early June 1991. Ten days after the initial posting of the survey, a reminder letter was posted to all households which had failed to respond to the survey. A further eleven days after this a second reminder letter was posted to all who had failed to respond to the survey. Valid responses were received from 49.5 percent of those households receiving a questionnaire.

5 SURVEY RESULTS

5.1 The Possum Problem

As was expected following recent media attention on possums, most respondents were aware that possums were causing problems in New Zealand. Only 2.3 percent of respondents were unaware of the problem, all of these being urban residents. Another 2.0 percent of respondents were unsure if a problem existed or not. Possibly a greater proportion of those who failed to reply to the survey were unaware of the problem.

The most significant possum problems as perceived by respondents were damage to native forests and wildlife and the spread of the disease bovine tuberculosis (Tb) with 85.0 percent and 71.3 percent of respondents respectively rating these as a bad or severe problem. Damage to soil conservation plantings, damage to exotic forests and damage by eating pasture, crops, shrubs, flowers and vegetables were considered bad or severe by over 40 percent of respondents (Table 1).

Table 1 Respondents' Perceptions of the Possum Problem

Possum Problem	Rating of the Possum Problem			
	No Problem	Slight Problem	Moderate Problem	Bad / Severe Problem
Spread of Tuberculosis	3.3	6.6	18.9	71.3
Damage to Native Forests and Wildlife	0.8	1.6	12.5	85.0
Damage to Exotic Forests	6.2	13.6	26.4	53.8
Damage by Eating Pasture, Crops, Shrubs,Flowers and Vegetables	7.7	23.9	25.5	43.0
Damage to Soil Conservation Plantings	3.0	13.3	27.9	55.8

Although possums are a problem in both rural and urban areas, a greater proportion of rural respondents reported a possum problem on their property. Whilst 50.9 percent of rural inhabitants reported a possum problem on their property, only 5.9 percent of urban dwellers did so. As possum densities are higher in rural areas than in urban areas, a greater amount of damage would be expected in rural areas.

Table 2 Percentage of Households with a Possum Problem, by Locality

Possum Problem	Locality		
	Rural	Township (1)	Urban
Yes	50.9	14.9	5.9
No	49.1	85.1	94.1
Total	100.0	100.0	100.0

(1) Township is defined as a settlement with less than 500 households

Possums caused damage on 20.9 percent of respondents' properties. Damage was diverse, ranging from damage of both exotic and indigenous vegetation to the damage of buildings. The most commonly reported problems were damage to gardens, fruit trees and other noncommercial exotic plants, with 34.3 percent of all damage reports relating to household gardens. Of those households reporting some form of possum damage or nuisance on their property, 59.7 percent recorded more than one form.

Table 3 Reported Damage Caused by Possums

Possum Problem/ Damage	Number of Complaints	Percentage of Total Complaints
Damage to Native Vegetation and Wildlife	34	11.8
Damage to Household Gardens	99	34.3
Possible Source of Tb Infection/ Extra Work from Tb Testing	60	20.7
Noise at Night time	10	3.5
Damage to Undefined Trees and Vegetation	21	7.3
Damage to Buildings/Fixtures	14	4.8
Eat Stockfood/Crops/Grass	26	9.0
Damage to Soil Conservation Plantings	12	4.2
Other	13	4.4
	289	100.0

5.2 Willingness to Pay for Possum Control

Respondents were asked to place a value on possum control by stating how much they would be willing to pay into a fund annually for possum control. For the open ended question, valid bids ranged from $0 to $5000 with 21.8 percent of respondents placing no value on possum control and 13.8 percent of respondents placing bids of $200/household/year or greater. The mean bid was $107.22 per year whilst the median bid was $23.00.

The mean bid is very sensitive to outliers. This problem can not be solved by enlarging the sample size as outliers are generally a constant percentage of the sample regardless of its size. A few outliers if genuinely invalid can significantly distort an estimate. A defensible approach to compensate for the effect of outliers is through the use of robust statistical estimators. This is explained in a number of texts such as Mitchell and Carson, (1989). In this study, the alpha-trimmed mean approach, with an alpha level of 0.10 was used. This meant that the top 10 percent of bids and bottom 10 percent of bids were removed and the mean value was recalculated. This gave a 10 percent trimmed mean value of $48.40.

For the dichotomous choice question, the best model (with standard errors in brackets) was found to be:

$$L_i = \underset{(0.0364)}{0.1451} - \underset{(0.0017)}{0.0102P} + \underset{(0.5596)}{2.2272F} + \underset{(0.4983)}{0.8231X} + \underset{(0.4173)}{1.1664IM} + \underset{(0.4205)}{1.1673IH}$$

where P = bid price offered
F = farmer, coded as 1 if respondent is a farmer, else coded as 0
X = possum problem, coded as 1 if respondent has possum problem on their property, else coded as 0
IM = income, coded as 1 if household income from $20,001 to $40,000 per annum, else coded as 0
IH = income, coded as 1 if the household income was over $40,000 per annum, else coded as 0

This model had a McFadden's R^2 of 0.329 and correctly predicted 73.0 percent of outcomes.

A mean willingness to pay was calculated by integrating under the logit curve from zero dollars to infinity. This was calculated as $184.06 per household per annum. Truncating the mean at the 90th percentile (this corresponds to where the probability of the respondent saying yes to the bid price is 10 percent), resulted in annual household payments of $173.73. The median willingness to pay, representing the point where 50 percent of households would be willing to pay into the fund was $116.11.

5.3 Aggregation of Bids

To aggregate the willingness to pay for possum control the number of households in the Manawatu-Wanganui region was multiplied by the individual willingness to pay amounts. From the 1991 census, there were 78,076 occupied dwellings in the Manawatu-Wanganui region (Department of Statistics, 1991). This was taken to represent the number of households in the region.

In aggregating the results, a number of assumptions can be made with respect to the households who declined to take part in the study. The most realistic assumption was considered to be that nonrespondents placed no value on possum control, therefore were not willing to fund it.

Table 4 Aggregation of the Willingness to Pay for Possum Control.

	Household Value	Aggregated Value ($ million per Annum)
DICHOTOMOUS CHOICE		
Mean	70.31	5.49
Truncated Mean	66.36	5.18
Median	44.35	3.46
OPEN ENDED QUESTION		
Mean	47.39	3.70
Truncated Mean	21.39	1.67
Median	10.17	0.79

The aggregate willingness to pay ranged from $0.79 million to $5.49 million. The large range of these bid values reflects the imprecise nature of the contingent valuation method. Differing assumptions can markedly affect the final outcome.

The dichotomous choice survey produced willingness to pay values of approximately twice the magnitude of the open ended question. This could be in part because some respondents may have wanted to demonstrate that they placed a positive value on possum control. Thus, if faced with a bid value higher than they would have offered in an open ended question, they may have replied yes to indicate that they placed some positive value on possum control.

Both the open ended and dichotomous choice approaches resulted in skewed distributions of prices. This suggests that a small number of respondents placed a very high value on possum control. The problem is how to reflect these when aggregating the values. If we ignore this problem we will use the mean value, however this may not reflect the valuation that the majority of the population places on possum control. The median has the advantage that it represents the largest amount that 50 percent of the population would pay. The trimmed mean has the advantage that it can adjust for outliers yet still reflect the proportion of the population that places a high value on possum control. In this study a 10 percent trimmed mean has been used, however if we increase the percentage of bids trimmed, the trimmed mean value will decrease until it becomes the median value.

5.4 Factors influencing Willingness to Pay for Possum Control

To check the influence that demographic and other data had on the open ended willingness to pay question, data was categorised and cross tabulations were carried out.

With reference to Table 5 it can be seen that households with a possum problem were willing to pay a significantly greater amount than those households unaffected by possums. Of those with a possum problem on their property, 65.9 percent were willing to pay more than $50 per annum compared to 25.0 percent of those without a possum problem. This could possibly be explained by the fact that those suffering from a possum problem on their property gain greater utility from possum control. Of those households which did not suffer from a possum problem, 76.4 percent were willing to make a bid of at least $1 per annum. This indicates that these respondents gain some value from possum control other than use value, i.e. reducing the possum problem on their property.

Rural residents placed a higher valuation on possum control than urban and township dwellers, with 60.0 percent of rural residents placing a bid of over $50 per annum as compared to 17.6 percent of urban and township residents. In part, this may be because more rural residents suffer from a possum problem on their property than urban residents.

As expected from economic theory, an increase in income resulted in a corresponding increase in bid price. Whilst 38.0 percent of those earning less than $20,000 placed a zero valuation on possum control, only 4.1 percent of those earning greater than $40,000 had a valid zero bid. This may be because a person on a higher income has more discretionary income.

Occupation had a significant effect upon the household willingness to pay. Of those respondents involved in agriculture, forestry and related industries, 71.1 percent had an annual household bid of greater than $50. Farmers are in the situation that possums may adversely affect their income if they spread tuberculosis and eat pasture. Only 22.5 percent of nonfarmers placed bids of $50 per annum or greater.

Table 5 Factors Affecting Willingness to Pay for Possum Control.

Factor Affecting Willingness to Pay	Annual Household Willingness to Pay ($)		
	0	1 to 50	more than 50
Possum Problem (1)			
Yes	4.9	29.3	65.9
No	23.6	51.4	25.0
Locality (2)			
Urban/Township	24.1	58.3	17.6
Rural	12.9	27.1	60.0
Household Income (3)			
20 000 and less	38.0	30.0	32.0
20 001 to 40 000	10.7	55.4	33.9
More than 40 000	4.1	49.0	46.9
Occupation (4)			
Farmer	11.1	17.8	71.1
Nonfarmer	20.8	56.7	22.5

(1) N=181, X^2=24.5, p=0.000 with DF=2
(2) N=178, X^2=34.0, p=0.000 with DF=2
(3) N=155, X^2=24.4, p=0.000 with DF=4
(1) N=165, X^2=34.1, p=0.000 with DF=2

6 CONCLUSIONS

The results of the contingent valuation survey showed a high degree of awareness about the possum problem among the respondents and a significant willingness to pay for possum control. This must be encouraging to decision makers as it serves as a justification for the work done on possum control from the view of those who ultimately fund it (in this case residents of the Manawatu-Wanganui region). Over 80 percent of respondents placed some value on possum control.

The current regional expenditure falls within the value range for possum control obtained from the contingent valuation surveys. This indicates that the current level of expenditure may be sufficient given the perceived benefits gained from possum control.

Results of the surveys showed that farmers placed a value on possum control that was approximately two times greater than that of nonfarmers, indicating that they derive a greater benefit from possum control. This could be due in part to the fact that bovine tuberculosis threatens the livelihood of cattle and deer farmers. Rural nonfarming households placed a value on possum control that was approximately 25 percent higher than urban and township residents. This is possibly a reflection of the greater incidence of possums in rural regions. Unlike farming households, the income stream of these

households is not likely to be adversely affected by possums. Although a majority of respondents did not suffer from a possum problem on their property many still valued possum control. This demonstrates that residents of the region derive benefits from possum control beyond use value. These may include option, existence and quasi-option values.

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THE ROAD TO RIO:
REFLECTIONS ON THE UNCED SUMMIT

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ABSTRACT

This paper takes a political economy view of the Earth Summit and discusses the problems it attempted to solve and the solutions it arrived at. The political economy approach is an attempt to describe a general framework that encompasses both economic and political phenomena. The testing of the framework lies in its success in explaining the events under discussion. In this case the Earth Summit is seen as a means to overcome the "free rider" problem, in order to achieve objectives in the interests of all countries.

INTRODUCTION

In 1972, the United Nations Conference on the Human Environment was held in Stockholm, representing the first major international meeting on the environment. In 1983 the UN General Assembly established the World Commission on the Environment and Development, chaired by Prime Minister Gro Harlem Brundtland of Norway, to examine the state of the environment and development in the perspective of the year 2000 and beyond.

The report of the World Commission, *Our Common Future*, made it clear that there are risks in current rates and patterns of development, especially if replicated in developing countries. The recommendations of the Commission led to a decision by the General Assembly in December 1989 to hold a United Nations Conference on Environment and Development in Brazil in June 1992. This became known as the Earth Summit.

Expectations were raised. Environmentalists saw the Earth Summit as the last great hope to save the planet from disaster. Developing countries, on the other hand, saw UNCED as a chance to raise the prominence of development on the international agenda and extract more financial assistance and debt relief in return for addressing environmental concerns of developed countries.

The Earth Summit was eventually held in Rio de Janeiro from June 3 to June 14 1992; many thousands of representatives and NGOs and the media attended; President Bush and over 100 other heads of state arrived and gave speeches; and finally everyone went home. From the initial high expectations, what was actually achieved?

Does the political economy model offer any help in this process? Many non-government organisations (NGOs) were consulted and expected to take part. The New Zealand country statement was being prepared as early as 1990 and went through several drafts as treatment of many issues was novel and, in certain cases, unacceptable to some. New Zealand had to ask what an individual country, especially one of its size, could do to influence the outcome?

[1] Senior authorship is shared. The views expressed in this paper are those of the authors and not necessarily the views of MAF Policy. The authors wish to thank Dr Peter Kettle of MAF Policy, a NZ delegate to UNCED, for observations and information he has provided.

THE POLITICAL ECONOMY VIEW

The political economy model attempts to integrate economic structures and processes with socio-political phenomena. Changes in economic processes are linked to the structure and goals of the various participants in the economy and the influence of external power holders and dominant interest groups. In the context of an international negotiation like the Earth Summit there is a conflict between national policies and international policies, and between the rich and the poor, in the realms of development economics and environmental protection. The conflict raises questions about the international distribution of national income and the sharing of world natural resources. The resolution of conflict is sought in an international negotiation and commitment to a new course of action.

The model attempts to describe a more general theory of behaviour than the normal profit maximising objectives of entrepreneurs. It seeks to incorporate the behaviour of groups of people into economic theory and places considerable emphasis on full information and incentives to act in favour of the group interest. It includes government both as politicians and as bureaucrats; each seeking what is in their self interest as in public choice theory. It seeks to explain by descriptive techniques how policy outcomes are achieved and places considerable emphasis on the distribution of power.

Economic models tend to regard Government as a passive partner implementing recommendations which maximise social welfare subject to the pursuit of some non-economic objectives. Political economy models treat Government as endogenous, and policy emerges from the interaction of rational policy makers and trade-sensitive economic groups (Moore, 1990). The objective of intervention and the choice of policy instruments are explained within the model. MacLaren (1991) identifies two sub-models: one group is referred to as "the social concerns," "social insurance" or "self-willed Government" group, and the other as "self-interest" or "clearing house government" group. The first group is permeated with the idea of social justice and the second by the idea of rational self-interest of policy makers. Politicians are assumed to choose policies in such a way as to maximise political support and re-election.

The two themes which best seem to suit the UNCED process are those analysing group behaviour and national self-interest. Individual nations enter the United Nations process with single and equal votes but soon appear to belong to various groups or blocs. Thus we have the G7, the G77, CANZ, North and South etc. In addition, non-government groups (NGOs) were also invited to the "summit" and were also consulted during the preparatory phase. Another "group" is the loose amalgam of middle class intellectuals who keep the conservation movement alive and growing mainly in developed countries. Groups are thus collections of like minded nations or people with common interests still pursuing their own goals either in the group or independently. They belong to MacLaren's social concern group.

National self-interest is the concern of the participating nations. Nations have to protect their own interests in the negotiations and form groups if they see advantage in it. In this scenario, politicians and bureaucrats tend to become merged, though not always, as disagreements within the US delegation demonstrated. While politicians

are seen as acting to maximise votes, bureaucrats can be seen as a group who want jobs and sometimes power and prestige. Bureaucrats in national governments would have different interests than those with positions, or seeking positions, in the United Nations organisations.

In terms of economic processes, the UNCED proposals raise costs for some nations, or reduce their access to resources, and impose taxes on others to help compensate the first group for what are seen to be inherent disadvantages (except where exploitation was the original reason for the disadvantage). In effect, income distribution is the underlying problem and gets reflected in debate about burden-sharing, protecting existing standards of living, official development assistance, property rights, and tropical forests etc.

THE PREPARATORY PROCESS: GREAT EXPECTATIONS

Mr Maurice Strong, the secretary general of UNCED, visited Wellington in November 1991. He described the meeting of world leaders in Brazil as a chance to write a "Magna Carta for the Earth" setting the agenda into the next century. He said the Earth Summit must establish a whole new basis for relations between the rich and poor, North and South, and make a concerted attack on poverty as a central priority. This was seen as equally imperative for environmental security as it was in terms of moral and humanitarian endeavours. "We owe at least this much to future generations, from whom we have borrowed a fragile planet called Earth" (UN 1992b, MfE 1992).

On the question of future planning, the UNCED secretariat issued a statement saying "There will have to be extraordinary cooperation between Governments, NGOs, the private sector, the financial community, and other constituencies, to put the decisions of the Earth Summit into effect. The Rio Conference of 1992 will shape our collective future - and this will require an unprecedented effort on the part of the global community to translate its results into reality. While the Earth Summit will constitute a test of nations' willingness to institute fundamental changes in economic behaviour, the challenges ahead will be perhaps far more daunting. Change is seldom easy" (UN 1992b).

The UN General Assembly established a Preparatory Committee (Prepcom) open to all member nations. Prepcom met in Kenya in August 1990, in Geneva in March 1991, in Geneva in August 1991, and in New York in March 1992 (Prepcom IV). In terms of General Assembly Resolution 44/228, Prepcom was responsible for drafting the two centrepieces of the summit, the Earth Charter and Agenda 21 (UN 1992b). Prepcom was also responsible for negotiating a binding convention on forest principles.

The Earth Charter was to be a declaration of basic principles for the conduct of nations and peoples in respect of environment and development to ensure the future "viability and integrity of the Earth as a hospitable home for human and other forms of life" (UN 1992b). Agenda 21 is a programme of action for the period beyond 1992, citing issues to be addressed with "priorities, targets, cost estimates, modalities and assignment of responsibilities" (UN 1992b). The Conference was expected to discuss the means of implementing the agenda through new and additional financial resources, transfer of technology, and strengthening of institutional capacities and processes.

The Rio Conference was also expected to discuss and agree to binding conventions on specific areas of environmental concerns, namely climate change and biological diversity. These were the subject of separate parallel negotiations by governments, and were to be ready for signing at Rio.

Climate Change: In 1988 the General Assembly adopted a resolution recognizing climate change as a common concern. The UN Environment Programme (UNEP) and the UN World Meteorological Organisation (WMO) then set up the Intergovernmental Panel on Climate Change (IPCC) to investigate the potential severity and impact of global climate change and to suggest possible policy responses. In December 1990 the General Assembly set up the Intergovernmental Negotiating Committee for a Framework Convention on Climate Change (INC) supported by UNEP and WMO. Negotiations were to run parallel to the PrepCom process with the aim of producing a convention ready for signing by Governments at the Conference.

IPCC had noted in a report to the General Assembly in 1989 that existing legal instruments and institutions were insufficient and a frame work convention was desirable. Such a convention could produce specific targets and quantitative reductions that would be added as protocols to the original convention (UN 1992a).

Biological Diversity: UNEP first called on Governments to consider an international legal instrument for the conservation and rational use of biological diversity in 1987. UNEP then established an Ad Hoc Working Group of Experts on Biological Diversity, which held three sessions between November 1988 and July 1990. On the basis of the group's final report UNEP established a Working Group of Legal and Technical Experts to negotiate the convention, later becoming the Intergovernmental Negotiating Committee for a convention on Biological Diversity (INC). The latter group met in Madrid in June 1991 and held its concluding session in Nairobi in May 1992 (UN 1992a).

The convention is meant to recognise the essential role of biological diversity in maintaining the life-sustaining systems of the biosphere, the significant reductions in biodiversity that are occurring as a result of human activities, and the urgent need to prevent and attack the causes of species and ecosystem loss at their source. It was hoped the convention would provide a mandate for integrating conservation and development objectives in government planning, and a mechanism for funding projects that combine the two in practice (WWF 1992). This raised a number of issues concerning the provision of financial aid to enable developing countries to implement the terms of the convention, questions of access to genetic materials and the sharing of profits from their future development, the use of new technologies in tropical forests, and the ownership and use of patent rights in the latter area (UN 1992a)

Forest Principles: Prior to the establishment of UNCED, the Food and Agriculture Organisation (FAO) had initiated consultations on a possible international legal agreement on conservation of forests. Under UNCED, some parties sought an agreement that would ban the cutting of tropical rainforests. Developing countries responded by seeking to extend any agreement to include consideration of forests in temperate and boreal (northern) latitudes, where much of the forest had been cleared long ago, and hence was not such an issue. As a result of this broad disagreement, PrepCom proposed a set of principles for the sustainable management of global forests as a basis for post-Summit negotiations on an international legal agreement on forestry.

Thus the emphasis was to be on global management of forests without highlighting any particular countries or forest type. There was a need to recognise individuals countries sovereignty in such matters and there was seen to be a need for policies that redressed the external indebtedness of developing countries which depend on exploitation of their forest resources. The question was raised whether the cost of such programmes should be shared by the international community (UN 1992a).

THE OUTCOMES OF THE EARTH SUMMIT: FAILED EXPECTATIONS?

The Earth Charter, Agenda 21, and the three conventions were to be the foundation for addressing the world's ills. Some saw them as an environmental blueprint, a grand design. One New Zealand commentator said that UNCED would be for the environment what GATT is to trade, suggesting a set of binding rules or perhaps even uniform international standards. Even by Prepcom IV, in New York in February 1992, it was clear these high expectations would not and could not be met. Indeed, it is doubtful that the General Assembly ever envisaged such an outcome, but that did not prevent interested groups from stating their own expectations for UNCED.

The Rio Declaration

The Earth Charter was re-named the Rio Declaration on Environment and Development, and the vision of a "Magna Carta" was gone. PrepCom IV agreed to re-affirm the Stockholm Declaration, and call for a continued global partnership for sustainable development. The new Rio Declaration includes phraseology which can only be appreciated by repeating some of it here[2]:

> "States have the sovereign right to exploit their own resources...."
>
> "Development must occur on a sustainable basis...."
>
> "Eradicating poverty and reducing disparities in standards of living are indispensable...."
>
> "Developing countries shall be given special priority...."
>
> "Developed countries should acknowledge the responsibilities they bear...."
>
> "Countries should pursue appropriate demographic policies...."
>
> "Trade policy measures for environmental purposes should not constitute a disguised restriction on international trade...."
>
> "States should promote the internalisation of environmental costs...."
>
> "The polluter should in principle bear the cost of pollution...."

These are but a sample from a statement with a preamble and 27 principles. The Declaration was largely completed at PrepCom IV but was subject to modification at Rio. Though the declaration is not legally binding, it is nevertheless aimed at giving Governments a strong moral commitment to adhere to its principles. However, once a consensus among all countries was reached, it seems the Declaration contains few principles that most governments would not already claim to be adhering to.

[2] As final texts have still not arrived from the United Nations at time of writing, the precise wording given here is not authoritative.

Agenda 21

By Prepcom IV, Agenda 21 had developed into a massive exercise in bureaucratic planning, describing literally hundreds of things that governments, international organisations, and NGOs "should do" to integrate the environment and development. The sheer volume of detail swamped any element of moral force, and required that Governments could only be expected to pick and choose those activities that were relevant and of high priority for their own circumstances.

Agenda 21 sets out, among other things, the financial and technical means by which specific action programmes are to be carried out. In particular this will mean identifying more effective help for developing countries to play their full part in meeting global challenges, while continuing their development in a environmentally sustainable way.

Agenda 21 is divided into four main sections:

I Social and Economic Dimensions;
II Conservation and Management of Resources for Development;
III Strengthening the Role of Major Groups
IV Means of Implementation

The Chapter titles of sections I and II are given in Table 1.

Table 1: Chapter Titles from Agenda 21: Sections I and II

1	Preamble
2	International cooperation to accelerate sustainable development in developing countries....
3	Combating Poverty
4	Changing Consumption Patterns
5	Demographic Dynamics and Sustainability
6	Protection and Promotion of Human Health
7	Promoting Sustainable Human Settlement....
8	Integration of Environment and Development in Decision Making
9	Protecting the Atmosphere
10	Integrated Approach to Planning and Management of Land Resources
11	Combating Deforestation
12	Managing Fragile Ecosystems: Desertification and Drought
13	Managing Fragile Ecosystems: Sustainable Mountain Development
14	Promoting Sustainable Agriculture and Rural Development
15	Conservation of Biological Diversity
16	Environmentally Sound Management of Biotechnology
17	Protection of the Oceans ... and Rational Use ... of their Living Resources
18	Protection of....Freshwater Resources
19	Environmentally Sound Management of Toxic Chemicals
20	Environmentally Sound Management of Hazardous Wastes
21	Environmentally Sound Management of Solid Wastes
22	Environmentally Sound Management of Radio-Active Wastes

Source: MERT (1992)

Again the detail of this document prevents a full appreciation of its contents. Within Chapter 14 on sustainable agriculture there are 11 programme areas, such as "Land Resources Planning for Agriculture," and within each programme a number of components, as shown in Table 2. New Zealand's national interests in this chapter, as distinct from the collective global interest, principally lie in Programme A, dealing with agricultural policy.

Table 2: Excerpts from Chapter 14, Agenda 21: Promoting Sustainable Agriculture and Rural Development

Programme A:	**Agricultural Policy Review, Planning and Programming ... with regard to food security**
Basis for action:	Need to integrate sustainable development considerations with policy analysis and decision-making re food security, international trade, etc
Objective:	Integrate sustainable development with policy analysis
Activities (10):	Eg Review national agricultural policy in relation to foreign trade etc; introduce policies leading to improved food security; and support early warning systems that assist food security
Data needed:	Global warning system for food emergencies
Coordination:	UN agencies to implement appropriate strategies; harmonise multilateral and agricultural trade policies, etc
Costs:	$US 3000 million per year
Scientific Means:	Assist farmers to apply technologies
Human resources:	Training for national and international policy analysts
Capacity:	Strengthening ministries of agriculture
Programme D:	**Land Use Planning**
Basis for action:	Inappropriate and uncontrolled land uses
Objective:	Harmonise planning procedures
Activities:	Eg Strengthen land use planning
Data needed:	Collect, monitor, disseminate information on resource use etc
Scientific Means:	Develop databases and geographical information systems
Coordination:	UN agencies establishing appropriate working groups
Costs:	US$ 1700 million per year
Human resources:	Training needs, and capacity building for establishment of planning and mapping units
Source: MERT (1992)	

New Zealand recognised that some of the relevant clauses could be interpreted in a way prejudicial to our interests. Our delegates were asked to ensure that the documents recognised the importance of trade liberalisation for alleviating poverty in poor countries, and that food security was defined as access to and ability to acquire food, rather than self-sufficiency.

At New York in March 1992, the New Zealand delegation successfully amended one phrase which encouraged government subsidies of agriculture, only to find the phrase still there when the results of Prepcom IV were circulated several weeks later. After many hours of work in the labyrinth of offices that was the UNCED Secretariat at Rio, and networking with sympathetic delegations, the NZ delegation succeeding in correcting the error. Such interventions illustrate how individual countries attempt to modify the wording in these international documents so that they do not come home to roost later!

Much of the rhetoric in Agenda 21 was familiar from FAO documents of recent years. What was new, perhaps, was the greater emphasis on environmental issues and the incorporation of these into a debate on development resources. The UN and FAO had visited most of the North-South issues previously and analysed the funding problems many times. What is new is the political rhetoric that goes with a large international meeting and the opportunity it provides to shift national positions, even if such shifts are slight.

Climate Change

The aim of this convention was to outline a set of general principles and obligations for international cooperation. Subsequent negotiations were to produce specific targets and quantitative restrictions on greenhouse gases, though this was contentious from the start. Before Rio, negotiations had already moved into detail of specific actions required, but disagreement on these issues had not been resolved.

The primary dispute concerned the setting of specific targets and timetables for reducing emissions of carbon dioxide, the leading greenhouse gas. Some countries supported a proposal to stabilise emissions at 1990 levels by the year 2000. Others (primarily the United States) wanted voluntary adherence to this goal on the grounds that there was insufficient scientific evidence on climate change to warrant such strong action. In the end, the non-binding language was adopted to get all major nations to sign the convention.

Agreement also had to be reached on the control of emissions of other greenhouse gases, financial aid to developing countries; conditions to be attached to any such aid; payments to developing countries whose forests serve as global carbon "sinks"; and the terms by which environmentally sound technologies were to be made available to developing countries. (United Nations 1992a)

The framework convention itself is full of resounding phraseology and generalities. Interspersed in the text, however, are phrases with a heavier moral tone,[3] eg:

> "Greenhouse gas emissions have come primarily from developed countries, and these countries have the main responsibility for combating climate change...."
>
> "Developing country compliance with the convention will be dependent upon the effective implementation of the provisions on financial resources and technology transfer...."
>
> "Developed countries should ensure efficient cooperation in technology transfer and technologies and know-how to developing countries on concessional, preferential and most favourable terms...."

[3] Precise wording cannot be confirmed until final documents are received from the United Nations.

Finally there was debate on, among other things, whether a new fund should be established under the convention or whether assistance for developing countries should be drawn from existing Official Development Assistance (ODA) funding arrangements. Along with this was the related issue of the right of donors to attach conditions to such aid.

Biological Diversity

The aim of the convention on biological diversity was to address plant and animal extinction worldwide. The biodiversity debate included a major focus on development, dealing with the maintenance of the world's stock of genetic resources for future use and development.

As with climate change, the debate on the convention was highly controversial, and many believed that the original intentions had been severely watered down by the time the draft convention reached Rio.

Again, liberal quotation helps to appreciate the sense of the convention[4]:

> "States have the authority to determine access to their genetic resources but should facilitate access to genetic resources for environmentally sound uses on mutually agreed terms...."
>
> "The countries benefiting most from biodiversity carry the main responsibility for the cost of its conservation...."
>
> "States should adopt measures for the recovery and rehabilitation of endangered species and for their reintroduction into their native habitats...."

Again, there are clauses which give special preferences to developing countries and recognition to disadvantaged groups:

> "Conservation of biodiversity and the sustainable use of biological resources require special funding for developing countries...."
>
> "Practices and innovations developed by indigenous peoples which contribute to the sustainable use of biological resources and conservation of biodiversity should be recognised and rewarded...."

In the end, the United States objected to this kind of terminology and refused to sign. The US saw the convention as an open-ended commitment to share technology with developing countries, and providing insufficient protection to the interests of the US biotechnology industry. Other issues concern, again, the establishment of a new funding facility, that intellectual property rights could be threatened by the transfer of environmental technology to developing countries, and that vast profits are made from genetic material originating in the third world (WWF 1992).

Forest Principles

Several weeks before the Summit convened in Rio, it was clear that no consensus could be reached on a binding convention on protection of the world's forests. The aim of developed countries was to contain the cutting of tropical rain forests. Developing countries had responded by suggesting that the principles cover "all" forest situations. Again there were some statements which could be agreed upon and some that could not. The following statements were accepted[5]:

> "States have the sovereign and inalienable right to utilize, manage, and develop their forests in accordance with their development needs... on the basis of national policies consistent with sustainable development ... on a sustainable basis, including the conversion of such areas for other uses ... based on rational land-use policies."
>
> "National forest policies should recognise and duly support the identity, culture, and rights of indigenous people, their communities and other communities and forest dwellers."
>
> "Specific financial resources should be provided to developing countries with significant forest areas which establish programmes for the conservation of forests including protected natural forest areas."

In the following paragraph, the words in italics were added at Rio before the final agreement:

> "Access to biological resources, including genetic material, shall be with due regard to the sovereign rights of the countries where the forests are located and to the sharing on *mutually agreed terms* of technology and profits from biotechnology products that are derived from these resources."

This amendment was made to reflect agreement on a contentious chapter of Agenda 21 dealing with terms for transfer of technology, and indicates the interrelationships between the different documents.

As with biodiversity, forestry has all the elements of the North-South debate of the last decade, focused all the more strongly because of the middle class reaction in the developed countries to further felling of tropical forest in Malaysia and Brazil.

Financial Resources

The secretary-general of the conference had estimated that the total foreign aid transfer implied by Agenda 21 was of the order of $US125 billion per year (Garran 1992). This would be the level of assistance if donor countries increased their development assistance to an average of 0.7 per cent of gross domestic product, as compared with current levels of 0.35 per cent. Implicit in the move to this increased level of aid would be the establishment of several new funding mechanisms to meet such a target as well as existing mechanisms, such as the Global Environment Facility, the UN's International Development Association, Regional Development Banks, the UN Development Programme (UNDP), and the UN Food and Agriculture Organisation (FAO).

The conference produced agreement on a text that committed developed nations to more official development assistance (ODA):

> "...countries reaffirm the UN target of 0.7 per cent of GDP for ODA, and agree to augment their programmes in order to reach the target...some countries agreed to reach the target by the year 2000...the Commission on Sustainable Development will review and monitor progress...."

[4] Precise wording not confirmed pending receipt of final documents.

[5] Precise wording is unconfirmed pending receipt of final documents.

This implied support for a new Commission on Sustainable Development, which had been contentious. The secretary general announced donor pledges worth $US6-7 billion (NY Times 1992) though some doubt was expressed whether this was new money.

THE POLITICAL ECONOMY OF UNCED: WHAT HAPPENED?

To understand what happened to the grand designs of the originators and sponsors of the Earth Summit, one needs to consider the nature of multilateral negotiations and the pressures on the key players.

The "Earth Charter" ended up as the Rio Declaration because of a fundamental difference between North and South. The South wanted a statement that laid the responsibility for environmental degradation, and especially global warming, squarely at the feet of the rich nations of the North. Further, they wanted recognition that they had a right to develop their own resources, that the North had an obligation to provide assistance, and if the North wanted the environment to be protected more than it had been during the development of the North's economies, it would have to provide even more aid and live up to previous commitments.

While the North would accept some responsibility for environmental problems, it would not accept it all, and similarly rejected the strong moralistic wording suggested by developing countries. Many would have preferred stronger language on the duties of nations to protect the environment, and the problems of population growth, but the South was equally unwilling to accept moral directions from the North. The only solution was to adopt a Declaration largely filled with platitudes. Financial issues are discussed further below.

Agenda 21 fell victim to a different set of pressures. Those who envisaged a volume of environmental standards to be applied in every country clearly never had a chance. Protecting the environment for future generations is a luxury affordable only to those who do not have to worry about how they will survive until the next harvest. Not even developed country governments were willing to cede sovereignty on the broad range of environmental issues in Agenda 21, which were of tremendous political significance to their voters, especially when it was impossible to achieve the degree of protection in the South which Northern voters wanted.

Thus, Agenda 21 became a long list of projects to integrate development and environmental policies, many of the projects pulled out of the files by UN and FAO officials for whom these projects are bread, butter, and jam. It is easy to become cynical, let alone bored, reading page after page of activities to be undertaken by governments, drawing upon the expertise of these same officials and their co-workers, adding up to hundreds of billions of dollars per year.

Proponents of a strong climate change convention had to accept a much weaker version to get President Bush to sign. Facing a difficult re-election campaign, President Bush refused to support any commitments which could potentially hinder the recovery of the sluggish US economy. He suggested that limits on carbon dioxide emissions might have done precisely that, though it is hard to imagine how it could have impacted the American economy before the election in November 1992. The political economy model would suggest that Mr Bush perceived that, on balance, signing a convention with fixed targets would have cost him votes.

The biodiversity convention ran into the same obstacle, only this time the United States was completely isolated. The US claimed the convention jeopardised future growth, because industry had insufficient protection for the profits from new technology, but neither developing countries nor other developed countries shared this concern. The treaty was signed by 153 governments at Rio, but not the United States.

The negotiations on forests encountered similar difficulties, but now it was the developing countries which dug in their heels. For Malaysia and Indonesia, in particular, forestry is a major part of their economies, which they were not prepared to sacrifice in order to accommodate residents of wealthy countries where the forests had already been cleared. While Malaysia was the most vocal, one suspects many developing countries were sympathetic.

OVERCOMING THE FREE RIDER PROBLEM

Given these entrenched interests, one might question the value of holding an international conference at all. This would overlook the visibility and pressure that such a conference can bring to bear on the issues, however. It is perhaps a tautology to say that multilateral conventions deal with global issues, but this was never more true than at UNCED. All governments and all peoples have a genuine interest in seeing the world make progress on resolving these issues, but they equally have an interest in bearing as little of the cost as possible. This is the classic free-rider problem so common in public sector economics.

By holding a high-profile summit, increased pressure can be brought to bear on those holding out and refusing to "pay their fair share." Prior to meeting in Rio, some governments expressed concern that the Earth Summit would become a "pledging conference" where world leaders would be expected to step to the podium and announce their country's contribution. In fact, this must be precisely what the organisers envisaged, for such dynamics are essential to overcome the free-rider problem. This was true for the binding conventions as well as for the issue of extra financial resources.

But for the dynamics to work, the organisers wanted President Bush to attend. Without him, the conference might have lacked the necessary visibility, and other countries would have felt less compelled to make financial contributions or cede sovereignty over certain policies if the United States would not do the same. Mr Bush realised that he was better off staying home than going to Rio to be criticised for refusing to sign anything or make any financial contribution. It was clear that those who did not measure up would be treated with scorn and painted as villains, at least for the duration of the conference.

Mr Bush agreed to attend the Summit when the mandatory targets were removed from the climate change convention, clearing the way for him to sign it. A few days before the Conference opened in Rio, he announced a forest initiative with the aim of "halting the loss of the world's forests by the end of the decade" (White House 1992) The US asked other nations to join in doubling financial assistance for forest protection. This was clearly intended to head off criticism that the US was not doing its part. But the US$150 million pledged by Mr Bush as a "down payment" failed to impress most observers.

And so no one got what they really wanted. President Bush attended, but was vilified all the same. Meanwhile, few commitments to new and additional financial assistance were made by governments.

ACHIEVEMENTS

In the end, 153 heads of state, or their representatives, signed the two treaties, one on global warming and the other on biodiversity. These must still be ratified by a minimum number of governments before coming into force. Delegates approved by consensus three non-binding documents: the statement on Forest Principles, the Rio Declaration on Environment and Development, and Agenda 21.

The treaty on biodiversity must be considered a success, and the Climate Change convention a limited success. The statement of forest principles is of more dubious value, unless negotiations continue to carry them into a binding convention. New Zealand, however, saw progress in the statement's recognition of the role that planted forests can play in meeting the world's need for timber products.

The Commission on Sustainable Development may prove a useful watchdog and browbeater, if it can decide how to effectively monitor the implementation of a plan so unwieldy as Agenda 21. Otherwise it runs the risk of becoming another UN bureaucracy buried in paperwork.

CONCLUSIONS

The political economy model could certainly be developed further to describe the behaviour of the participants at the conference, in particular the common interests that led to bloc behaviour. The conference itself showed the political process working to finer and finer levels of decision making. Although a parallel conference was organised for NGOs, it appears that by reason of distance and then of urgency, the NGOs were largely shut out of the final decision making. In the end, it is governments which must negotiate the wording of documents they are asked to sign on behalf of their citizens.

But the common interest groups of nations remained paramount in the United Nations process, helped no doubt by procedures developed over many years. By and large, the issues at Rio were the same ones that dominated the international agenda for the past two or three decades, and the voting blocs that have developed over that time remained at the centre of the action. One development worth noting is the increasing prominence of the Pacific Island states on the issue of climate change.

The final documentation reflects what could be agreed at the lowest common denominator level between the developed nations or high standard of living nations and the less developed nations with a lower standard of living.

In the end, the Earth Summit was mostly about the environment, not about development, because the public in developed countries is interested in, and at least somewhat willing to pay for, action on the environment. Development aid is probably less popular than ever; witness the "America First" theme in the US presidential primary elections.

The Earth Summit had its successes. Many, however, will say that it was too little, too late. The challenge for those seeking action will be to channel the outcomes of Rio into concrete action by member states. On some issues, efforts will be best focussed at local and national governments, especially given the difficulty of negotiating international agreement, which the Earth Summit made all too clear. However, on truly global issues such as climate change, it will be necessary to continue building international consensus on action needed to solve the environmental problems of the planet Earth.

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C-3 MARKETING AND TRADE POLICY

A paper presented to the Australian Agricultural Economics Society

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Draft paper:

THE ROLE OF MARKETING MANAGEMENT IN AGRICULTURAL MARKETING

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Abstract

A dichotomy exists between agricultural and business marketing theory. Agricultural marketing theory focuses on policy and distribution channel issues and has not evolved with the marketing management orientation found in the business marketing literature. Although business marketing has developed an interdisciplinary approach to research, agricultural marketing continues to rely on its economic foundations. This paper discusses the role which marketing management plays in agricultural marketing. It suggests that the marketing strategies of farmers are not adequately described by either the business or agricultural marketing disciplines. An ongoing empirical study analyses the complexity of the farm business marketing strategy process.

Introduction:

Business marketing[1] theory suggests that businesses are more likely to succeed if they utilise certain marketing management approaches or techniques. For example the marketing concept, a cornerstone of business marketing thought, stresses the importance of determining the needs and wants of consumers and delivering the desired satisfactions more effectively and efficiently than competitors (Kotler, 1986; Clark, 1987; Collins, 1989). Philosophies from marketing management have recently been applied to almost every industry from insurance to travel and hospital services, but not usually to farming. Schools of business management surrender the theory of agricultural marketing to agricultural specialists and agricultural universities (Bartels 1983). One aspect of this has meant agricultural marketing issues are studied using techniques that predominantly originate from within the agricultural economics discipline.

Concerns have been raised about a dichotomy which appears to exist between agricultural and business marketing theory. Agricultural marketing theory does not seem to incorporate managerial marketing paradigms. Associated concerns relate to how farmers are not perceived to utilise marketing management techniques.

This paper identifies the role that marketing management plays in agricultural marketing, both in theory and in practice. It is divided into two parts. The first examines the theoretical similarities and contrasts between the agricultural and business marketing disciplines at their most general level. The degree to which marketing management paradigms have been incorporated within the scope of the two disciplines is highlighted. Variations which exist in definitions of the disciplines, their historical development, the techniques they use to research marketing problems, and their scope or subject matter are outlined. The second looks more specifically at the role of marketing management for farm businesses. It is argued that this is the most relevant area for research.

Part one: The Role of Marketing Management in Agricultural and Business Marketing Theory

Although there is no generally accepted definition of agricultural marketing, agricultural marketing is generally viewed as part of the economic system (Ritson, 1986; Bateman, 1976), and is widely recognised as involving the exchange process.

Definitions of Agricultural Marketing include one by Shepherd and Futrell (1982) who state *"in physical terms, agricultural marketing begins when the product is loaded at the farm gate, and ends when the goods reach the consumers table. It is concerned with such physical things as trucks, refrigerator cars, and packing plants and also with technological developments in preservation and packaging"*. However the title of their book, ***"Marketing Farm Products, Economic Analysis"***, indicates the approach they take is mainly an economic one. They continue *"the economics of* (agricultural) *marketing takes in more territory. It deals with three separate but related problems: consumers demands for farm products, the price system that reflects these demands to distributors and producers, and the methods or practices used in exchanging title and getting the physical product from producers to consumers in the form that they want and the time and place desired"*.

[1] To avoid confusion *marketing* as it is referred to in business literature will be referred to as business marketing in this paper.

In a World Bank symposium on Agricultural Marketing Strategy and Pricing Policy Elz (1987) describes agricultural marketing as *"all activities that are involved in transforming, storing and transporting agricultural products to the domestic or foreign buyer".*

Interpretations of marketing found in agricultural marketing textbooks are similar to agricultural marketing definitions. For example, a definition widely quoted in reviews of agricultural marketing (Barker 1989, Ritson 1986, Muelenberg 1986) is given in Kohls book, "**Marketing of Agricultural Products**". In the fifth edition of the book Kohls and Uhls (1980) describe marketing as *"the performance of all business activities involved in the flow of food products and services from the point of initial agricultural production until they are in the hands of consumers".* Kohls description suggests that agricultural marketing has a performance component. It indicates the discipline is concerned with increasing efficiency.

Agricultural marketing definitions indicate the discipline focuses on the workings of the distribution system. Most are restrictive as they limit farmers marketing activities to sales tactics for goods already produced. Production planning is excluded from the marketing process.

Although there is no universally accepted definition of marketing (Barker 1989), it is generally accepted that marketing, like agricultural marketing involves the exchange process. For example Kotler (1972) defines marketing as the *set of human activities directed at facilitating exchange.* More recent interpretations also recognise the importance of satisfying customer needs and wants in order to fulfil business objectives. The latest definition from Kotler's popular "***Principles of Marketing***" describes marketing as "*a social and managerial process by which individuals and groups obtain what they need and want through creating and exchanging products of value with others* (Kotler and Armstrong 1991).

Stanton, (1981) states "*the essence of marketing is a transaction-an exchange..intended to satisfy needs and wants.*" He continues *"marketing is total system of business activities designed to plan, price, promote and distribute want satisfying goods and services to present and potential customers".*

Business marketing definitions seem to have a common theme. In order to satisfy business objectives (which often involves making a profit), a firm must produce or create goods and services which satisfy consumer needs and wants.

Most farmers deal with industrial buyers rather than the final consumers of their produce. Therefore it is also relevant to review industrial marketing definitions. There seems to be more consensus as to what industrial marketing incorporates. It is generally recognised that industrial marketing involves the marketing of goods and services for further processing or use in a production process. For example Webster's (1984) "***Industrial Marketing Strategy***" defines Industrial marketing as *"the marketing of goods and services to industrial and institutional customers".* Stanton (1981) describes industrial marketing as the *"marketing of industrial goods and services to industrial users"* where industrial users are "*businesses or institutions that buy products or services to use either in making other goods or services or conducting their own operations,*" and industrial goods are "*intended for use in making other products or operating a business or institution.*" A similar interpretation defines industrial marketing as the "*marketing of goods and services to formal organisations for their use in furthering organisational objectives"* (Vinson and Sciglimpaglia 1975). Apart from recognising the distinct needs and capabilities of industrial buyers or markets, industrial marketing definitions are not greatly different from those for business marketing. They still recognise the importance of satisfying the

consumer (industrial buyers) and deal with achieving business objectives.

Business and industrial marketing definitions contain two major points that are not normally explicitly stated in agricultural marketing descriptions, or marketing as it is defined in agricultural marketing texts. These points are:

1. marketing is concerned with a consumer orientation and therefore has a behavioural component:
2. fulfilment of business objectives are the normal aim of business marketing.

To conclude, definitions of agricultural marketing differ from business marketing definitions. It will be shown that a gap also exists between the subject areas addressed within the disciplines; however this gap has not always existed.

The history of agricultural marketing and business marketing:

To gain a better understanding of the development of business and agricultural marketing this section will discuss the history of the two disciplines. Popper (1962) suggests that the theories a discipline uses to solve its problems and not its subject matter, should be used to define a discipline. Therefore the development of approaches used to research marketing problems, as well as the scope of the disciplines will be briefly reviewed.

Early marketing theory owes much of its development to what we consider today to be the analysis of agricultural marketing problems. The disciplines of agricultural and business marketing emerged from economics and the economic function of distribution in the early 20th century. Early marketing researchers and academics were economists who studied the distribution system (Kotler, 1972; Barker, 1983; Bartels, 1983). Business and agricultural marketing were not considered to be separate disciplines (Muelenberg 1986).

Many agricultural marketing studies made during the early twentieth century aided the development of both disciplines. For example, Jones and Monieson's (1990) "***Early development of the Philosophy of Marketing Thought***" discusses how agricultural marketing publications during the early 20th century aided development of the philosophy of marketing thought. They cite works including Henry C, Taylors, "***The prices of Farm Products***", H.E. Erdman's "***The Marketing of Whole Milk***" (1921), Hilbards (1921) "***The marketing of farm products***", and Macklin's (1921) "***Efficient Marketing for Agriculture.***" Welds (1920) book "***The Marketing of Farm Products***" is also recognised as a classic early study of marketing (Hunt 1976, Muelenberg 1986).

Business and agricultural marketing theory moved together until the 1950's . The concept of distribution and the study of distribution problems were central to both disciplines. However reviews of agricultural marketing theory development (Muelenberg, 1986; Bateman, 1976) indicate that since the 1950's agricultural marketing has not moved with business marketing theory. While agricultural marketing has continued to rely on its economic foundations business marketing has developed a interdisciplinary approach, focusing attention on the marketing management activities of individual businesses.

Business marketing has changed from a study of economic activity where the marketer was considered to be the initiator of marketing actions, to a study of the exchange of values where the consumer has greater power than the marketer (Sheth and Gardner 1982). Therefore business marketing theory has incorporated ideas from the behavioural sciences to supplement concepts from economics in an attempt to understand consumer

behaviour (Sheth and Gardner, 1982; Despande and Webster, 1989). Contributions from the behavioral sciences include those from psychology, sociology, anthropology, and political science (Ritson, 1986; Bartels, 1962). Additional extensions to marketing theory have originated from the management sciences (Bartels, 1962; Horsky and Sen, 1980).

Agricultural marketing theory has not developed the interdisciplinary approach of business marketing. Instead, it continues to follow the mainly economic approach utilised by both disciplines prior to 1950. As a result agricultural marketing has failed to recognise large areas which are very important in business marketing theory. Before summarising the differences that exists between the two disciplines it is wise to briefly examine the scope of agricultural and business marketing theory.

The scope of Agricultural Marketing:

Vastly different perceptions of agricultural marketing have lead to difficultly in reviewing the disciplines scope or subject matter. These perceptions range from the business schools view which suggests that marketing involves the employment of the marketing concept to neoclassical studies of marketing functions and institutions (Watson, 1983). Agricultural marketing does not have the extensive literature development of business marketing. Although now almost twenty years old, the most comprehensive reviews of agricultural marketing theory remain those by Breimyer (1973), and Bateman (1976). The areas they identify still appear to be popular topics in agricultural marketing theory. More recent assessments include efforts by Meulenberg (1986), and Ritson (1986).

Breimyer (1973), identifies three distinctive schools of thought or approaches to agricultural marketing. The first approach is the most conventional and traditional of the three, taking the simplistic view that marketing is all that happens to produce after it leaves the farm gate. Production is on the farm with marketing conjured to be off-farm. Therefore marketing is envisaged to incorporate everything that happens between the farm and the consumer. The second and third schools of thought both suggest that this approach is inappropriate.

The second approach is the most common of the three and focuses on the coordinating role of marketing. It perceives that marketing occurs where identity changing transformations take place and that marketing is a coordinator for economic activity. Price is most important to this school of thought as it is seen to play the most important coordinating function. Agricultural marketing is acknowledged to encompass all activities but the management of the farm business.

Breimyer views the third approach as an allegiance to market development. Attention is focused on cultivating demand and generating purchasing power among consumers by differentiating and promoting products. The third school of thought is closest to the industrial marketing approach, centring on consumption and consumer behaviour. It seeks to erase the lines between production and marketing of farm products. While this approach has experienced "difficulties of communication (Breimyer, 1973)" with the other schools of thought, it is closer to the marketing management approach used by business schools. It therefore presents a popular research topic for agricultural marketers.

Bateman's (1976) review article takes a different approach to that by Breimyer (1973). Bateman claims agricultural marketing theory focuses on macro-issues and government policy. Unlike Breimyer, Bateman does not outline the economics of traditional agricultural marketing. Instead he reviews the scope of agricultural marketing and details the role which alternative theoretical business marketing frameworks have

in agricultural marketing research. Although traditionally seen as a policy subject, Bateman suggests agricultural marketing may also be able to viewed as a business subject, or an aspect of social marketing.

Muelenberg (1986) takes a similar approach to Bateman (1976), firstly reviewing the evolution of agricultural marketing theory and then illustrating a marketing management approach to agricultural marketing. Muelenberg feels that as most functions in agriculture have been assumed by the government, agricultural marketing has developed with a policy orientation. He identifies and references studies embraced in the agricultural marketing literature field covering many topic areas including market structure analysis, marketing efficiency studies, regional and spatial analysis, economic demand analysis and price analysis, competition within the agricultural marketing sector, and marketing institutions (eg futures markets, cooperatives, statutory marketing boards). Physical distribution is seen as a popular research topic; especially the areas of transportation and storage.

Ritson's (1986) essay, "*The Scope and Subject Matter of Agricultural Marketing*" emulates Bateman and Muelenberg in acknowledging the importance of government policy in agricultural marketing. Ritson recognises that agricultural marketing is usually regarded as the affair of special institutions created to improve the situation of the whole sector. A quote from Ritson's essay states "*The subject of agricultural marketing developed as the study of the economic structure and efficiency of the agricultural marketing sector, and the governments role in intervening to improve the performance of agricultural markets and increasing the expenditure on food received by farming*" Ritson claims that this is the way agricultural marketing continues to be taught in many universities.

Parts of other articles also examine the subject matter of agricultural marketing. Watson (1983) recognises that there is considerable overlap between the subject matter of agricultural prices and agricultural marketing courses, indicating the importance of pricing studies to agricultural marketing. He also notes the prominence of studies on horizontal and vertical, competition, and agricultural marketing institutions. Zwart, (1986) indicates that agricultural marketing theory normally takes an industry perspective. It examines the way in which firms interact to determine incomes, prices and trade flows within industries.

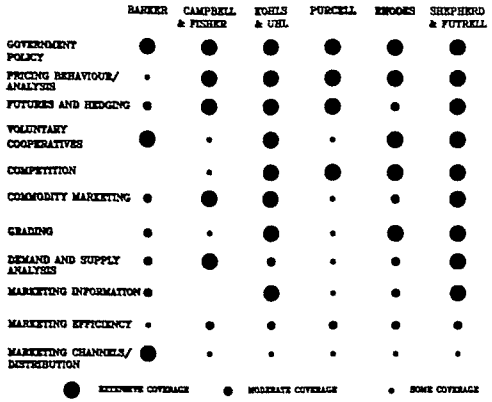
Review articles highlight the difficulty of trying to standardise what agricultural marketing is. However by examining the topics or subject areas addressed by popular agricultural marketing texts a reflection of common themes can be gained.

Table one presents the eleven major subject areas addressed by six common agricultural marketing textbooks. Areas which form the focus of most discussion are indicated by headings on the left side of the table. The relative importance[2] of subject areas to each text is represented by the size of the circles in the table. No circle means the topic is not described in that text. Areas popular in all texts are presented on top of the table, followed by those not covered in depth by every book. Many areas are interrelated, therefore they can not be considered as entirely separate topics. All books are written by agricultural economists, with no authors appearing to have a strong background in the behavioural sciences.

[2] In terms of the extent to which a text describes each subject area.

Table one: Subject Areas Addressed in Agricultural Marketing Texts:

Topic / Author



An examination of agricultural marketing texts identifies similar topic areas to articles which review the subject matter or scope of the discipline. Studies of government programmes or policy and the reasons for intervention appear to dominate agricultural marketing research. Pricing behaviour or analysis is a popular research area, as is investigation of the level and nature of competition, and marketing efficiency. Studies of the functions of the agricultural marketing system include those which analyze grading, transportation, market information and storage. Other research examines the marketing of commodities or institutions involved in agricultural marketing; for example cooperatives and marketing boards. Most of this research involves the study of marketing or distribution channels within the agricultural marketing sector. This topic seems to be more important than the low position on the table indicates.

Following discussion briefly reviews the scope of business marketing. Marketing management is defined and the role it plays in business marketing theory outlined.

The scope of business marketing theory:

Business marketing theory covers such a varied and wide ranging domain that reviewing it's scope would be a major task which is outside the realms of this paper. It has not been guided by a single paradigm (Ardnt 1985), but applies a hybrid of other disciplines to it's area's of interest. It has such wide ranging subject areas that the disciplines conceptual boundaries may never be fully established (Krapfel 1982). We will briefly note the wide ranging scope of business marketing but instead of attempting to review the entire scope of business marketing, we will focus attention on some parts of the discipline which seem appropriate for dealing with agricultural marketing problems, but are rarely used by agricultural marketers.

Hunt (1976) reviews the scope of marketing and indicates that marketing includes "*such diverse subject areas as consumer behaviour, pricing, purchasing, sales management, product management, marketing communications, comparative marketing, social marketing, the efficiency/productivity of marketing systems, the role of marketing in economic development, packaging, channels of distribution, marketing research, societal issues in marketing, retailing, wholesaling, the social responsibility of marketing, international marketing, commodity marketing and physical distribution*" as well as others. The Journal of Marketing's literature review (October 1991) classifies marketing under five broad subject headings and a number of subheadings as detailed in table 2.

Table 2: Subject Headings for the Journal of Marketings Literature Review:

1. THE MARKETING ENVIRONMENT	
Consumer Behaviour Legal	Political, and economic Issues
Ethics and Social Responsibility	
2. MARKETING FUNCTIONS	
Management, Planning, and Strategy	Retailing
Wholesaling	Channels of Distribution
Physical Distribution	Pricing
Product	Sales Promotion
Advertising	Personal selling
Sales Management	
3. SPECIAL MARKETING APPLICATIONS	
Industrial	Nonprofit, political and Social Causes
International and Comparative	Services
4. MARKETING RESEARCH	
Theory and Philosophy of Science	Research Methodology
5. OTHER TOPICS	
Educational and Professional Issues	General Marketing

Many of the subject areas identified in this table can be considered as part of the marketing management discipline, as they place emphasis on the marketing management activities of individual businesses. Marketing management involves managerial decision making and planning concerned with the set of controllable variables a firm uses to satisfy its market (McCarthy and Perreault 1984, Kotler, 1972). These controllable variables are generally referred to as the marketing mix and consist of price, place, product and promotion activities. The emphasis of marketing management is at the business level, and concerns making a profit (Hunt 1976), or satisfying business objectives (Kotler and Armstrong 1991). Kotler and Armstrong (1991) define marketing management as *"the analysis, planning, implementation and control of programmes designed to create, build and maintain beneficial exchanges with target markets for the purpose of achieving organisational objectives."*

A central idea in marketing management theory is the marketing concept (Kotler, 1986; Stanton, 1980; Kohli and Jaworski, 1990). It suggests that a business can best achieve objectives by determining the needs and wants of target markets and delivering the desired satisfactions more efficiently and effectively than competitors (Kotler and Armstrong, 1991; Clark, 1987; Collins, 1989).

At present marketing management with its focus on individual firms dominates the business marketing discipline (Wind and Robertson, 1983). Most introductory marketing textbooks contain large areas describing the subject area. Kotler and Armstrong (1991) devote a considerable part of their "***Principles of Marketing***" text to addressing marketing management issues. McCarthy and Perreault (1984) explicitly state their text focuses on *"management orientated micro marketing"*.

Likewise, business marketing journal articles have found marketing management a popular topic. In a special anniversary issue celebrating the first forty years of the ***Journal of Marketing*** Grether (1976) reviews articles from four decades of ***Journal of Marketing*** publications. He identifies marketing management as an area of high and continuing interest, something that is persisting today. Journals which specialise in areas of marketing management include the ***Journal of Marketing Management, Industrial Marketing Management*** and ***Sales and Marketing Management.*** The prominence of the discipline is highlighted by the publication of at least one new journal in the early 1990's; "***Perspectives on Marketing Management***" published by John Wiley, New York.

A key area embraced by marketing management theory involves marketing strategy. For an individual business, marketing strategy can be defined as *"the allocation of resources to achieve a sustainable competitive advantage in selected product markets* (Wietz and Wensley 1984)". The subject area has a broader perspective then traditional marketing management (Wind and Robertson 1983) and has close links with business level strategy (Wietz and Wensley 1984) and the strategic management disciple. It is usually associated with elements of the marketing mix (Webster 1984) and the associated synergies and relationships with other functional areas of the firm (see Biggalike, 1981; Anderson, 1982; Day and Wensley, 1983; Wind and Robertson, 1983; Walker and Ruekert, 1987).

The dichotomy between the two disciplines:

In the literature it is recognised that a dichotomy exists between agricultural and business marketing as the marketing management approach is not prominent in agricultural marketing theory. Bateman (1976) suggests that agricultural marketing has traditionally incorporated everything that happens between the farm gate and the consumer, therefore encompassing areas which "the purist" may not consider marketing. While analysis of government intervention and policy form the focus of agricultural marketing theory, studies of the objectives and decisions confronting individual businesses (marketing management) are central to business marketing theory. Bateman acknowledges that logistics is a topic on which agricultural marketing concentrates, but is only one part of business marketing theory.

Muelenberg (1986) also recognises the gap that exists between the two disciplines. He notes that agricultural marketing theory has not adopted the marketing management approach of business marketing theory. While marketing management has become interdisciplinary, adopting concepts from the behavioural sciences and elsewhere, agricultural marketing continues to rely on its economic foundations.

While this difference between the two disciplines clearly exists, parts of agricultural marketing theory seem to be moving towards the marketing management approach employed by business marketing. Breimyer (1973) was the first to identify the agricultural marketing school of thought focusing on business marketing theory. This school of thought seems to be growing more prominent. For example Watson (1983) acknowledges that

during the 1970s a minor paradigm shift occurred in agricultural marketing with a move towards business marketing. He notes successive editions of Kohl's agricultural marketing textbook (1972 and 1980), change to describe the marketing concept. Ritson (1986) also believes that since the 1970s agricultural marketing theory has become more closely aligned with business marketing. He suggests that agricultural marketing should focus on government policy and all that it entails, because in European agriculture the government controls elements of the marketing mix.

A parallel to this in New Zealand, is the activity of marketing boards which in some cases have exclusive control of the price, place and promotion of agricultural products. These organisations have carried out many marketing management practices on behalf of farmers. However many other parts of the agricultural sector are free from government intervention (e.g. New Zealand crop farming). Even agricultural sectors facing high government intervention, are little different from industrial manufacturers in similar situations. For example many industrial manufacturers export produce to overseas markets and are subject to import restrictions. Business marketing theory recognises that while analysing government policies are important to these manufacturers. it only forms part of their external market evaluation.

Muelenberg (1986) identifies a number of agricultural marketers who have partially incorporated the marketing management approach, but mainly focus on the behaviour of agribusiness companies (for example Bresch; 1981, and Yon, 1976), rather then individual farmer firms. Out of the books examined in table one, Barker (1989) takes a more marketing management approach than most agricultural marketing texts. However he focuses on the direct applicability of present business marketing principles to farmers, not recognising that in practice farmers may use different but equivalent approaches to those identified by business marketing theory. Rhodes (1978), aims to integrate a managerial approach to marketing with applied economic theory, but his book more closely resembles a traditional agricultural marketing book than a business marketing text.

Agricultural marketing research of a marketing management nature continues to be outside of the norm. However many articles suggest that agricultural marketing should take a more interdisciplinary approach to research.

Traditionally, agricultural marketing studies have been conducted by agricultural economists using economic principles and techniques. These principles and techniques have recently been subjected to criticism. Horsky and Sen (1980) examine the interfaces between marketing and economics. In their opinion economic theory is too narrowly focused to solve complex marketing problems. Bateman (1976) suggests that agricultural marketing theory is restrictive and pays insufficient attention to business marketing. Concepts from the behavioral sciences should be used to complement economics. Muelenberg (1986) agrees and recommends that agricultural marketing should be more closely coordinated with business marketing adopting a marketing management approach to research. As many farmers have non-profit goals the agricultural marketing may benefit from incorporating non-profit marketing ideas from the business marketing discipline.

Criticisms of researchers who confine their work within a narrow economic focus also exist within the broader confines of the agribusiness discipline. Some criticisms focus on the agricultural economics discipline. Departments of Agricultural Economics have been seen to be too narrowly focused with little or no concept about what business is really about (Wallace 1989). Sonka and Hudson (1989) describe how recent examinations of agribusiness programmes recognise "the efficacy of economics as the underlying discipline for agribusiness efforts." However they suggest that in the future agricultural economists will turn

to other disciplines and use traditional mainstream economics relatively less. As researchers confront more complex problems concepts from the behavioural disciplines will be used with increasing frequency, especially for research analysing managers decisions and actions.

A Conclusion on the Theoretical Role of Marketing Management:

Agricultural marketing theory has responded to marketing problems which it perceives exist within the agricultural sector. The peculiar nature of the industry has meant some of these problems differ to those facing other industries, making alternative theories and techniques necessary to analyze problems. If the marketing management activities of businesses within the agribusiness sector are included within the domain of agricultural marketing theory, concerns that agricultural marketing discipline should adopt a more interdisciplinary approach to research, incorporating marketing management paradigms seem real. However studies which suggest agricultural marketing theory should be more closely aligned with business marketing theory do not point out specifically what should be done at the firm level. Businesses in the agricultural marketing sector include farmers and other, often larger more sophisticated agribusinesses. In practice many agribusiness firms appear to be aware of and utilise marketing management theory in the marketing of their farm products. This is particularly true for firms in the food processing sector. The major areas of concern appear to be at the farm level or in the markets for relatively unprocessed products. Part two of this paper reviews research which examines the marketing activities of farmers. It concentrates on literature from agricultural marketing and other disciplines which surveys and analyzes the marketing strategies of farmers.

Part two: The marketing strategies and tactics of farmers:

Traditional agricultural marketing theory does not recognise the complex array of marketing management decisions which modern farmers encounter. The biological attributes of farm produce and small scale nature of farm businesses is perceived to limit the applicability of marketing management principles to farmers (Bateman 1976). Government regulations, some of which empower statutory organisations such as marketing boards are often presumed to control the farmers marketing mix (Ritson 1986). If these regulations are not present, theory frequently suggests that producers should persuade the government to introduce controls. Otherwise it encourages farmers to group together to form cooperatives which control their marketing activities (Manwaring 1979). Therefore literature limits farmer marketing to sales activities which occur with a change of ownership.

Farmers are more actively involved with marketing than traditional agricultural marketing theory recognises. The traditional view which sees agricultural firms as thousands of small business producing a uniform product (Ritson 1986), acting as price takers, and facing only limited marketing alternatives is an oversimplification. Hanf and Kuhl (1986) suggest that any farm may use a number of marketing activities to improve its success by reducing input prices and/or an increasing farm gate output prices. Some agricultural marketing texts (eg Purcell, 1979; Kohls and Uhl, 1985; Barker, 1989) detail how farmers can store crops, influence the quality of their produce and choose different market outlets to sell produce.

Agricultural marketing theory perceives that the peculiarities of farm businesses, their produce, and the environment they operate in, make farm enterprises different from other businesses. Therefore business marketing principles are not recognised as being applicable to farmers. However the differences between many farmers and other small business operators are not as great as they once were. American producers are

facing a more unstable and uncertain environment than in the past (Edleman et. al. 1990; Harling and Quail, 1990). European farmers are facing the threat of less protection and more competition. The recent deregulation of the New Zealand economy and agricultural sector (see Sandrey and Reynolds 1990) has increased the number of marketing options available to farmers. Some sectors like the New Zealand cropping industry, are totally free from government intervention. These factors have led to the management challenges in farm businesses becoming more like those facing other businesses.

The change in farmers operating environment has led to calls for farmers to more actively utilise principles of marketing management. Politicians, public speakers and the farmer press have all criticised farmers for their lack of attention to marketing. Academic literature recognises the belief that prosperity in farming is dependent on the agricultural sector (including farmers) adopting the marketing concept (Ritson 1986), and that farmers have been called upon to market their way out of current problems (Blight 1984). However these ideas are not new. Twenty years ago Bateman (1972) pointed out that farmers, more than other businesses, were being criticised for paying insufficient attention to the market.

Literature continues to suggest that farmers may benefit from utilising marketing management principles. It generally takes the viewpoint of Carpenter (1972) who feels that farmers would gain from employing a marketing orientated attitude to management. Often this involves implementing the marketing concept (Bateman, 1972; Fletcher and Napier, 1981), or a move from selling to marketing (Black, 1979). Ferris (1988) recommends that farmers should develop a successful marketing plan and follow it. As a first step farmers should determine what buyers want, then how much to produce, what quality to produce, and where, how, and when to sell. Tilley (1989) suggests that marketing planning is important to farmers adopting alternative agricultural enterprises. For example for crop farmers breeding new varieties of crops.

Several books also stress the perceived importance of marketing management to farmers. Barker's (1989) agricultural marketing text suggests that marketing management considerations should be present in the majority of farmers management decisions. Futrell (1982) feels that marketing is becoming more important for farmers and writes what he considers to be a practical book on marketing for farmers. Two recent farm management texts also recommend that farmers should use marketing management concepts. Turner and Taylor (1989) outline the importance of a marketing orientation to farmers, suggesting farmers should segment their market and grow produce which satisfies the requirements of their target markets. Boehjle and Eidman (1984) believe marketing and market planning is an important part of farm management.

The perceived need for farmers to utilise marketing management principles is highlighted in articles which suggest it is necessary to teach farmers these concepts. Manwaring (1979) feels that farmers do not have adequate knowledge to apply marketing concepts without further education. He talks about the necessity of educating farmers in marketing, stressing the need spell out the marketing concept, but mainly focuses on the profits to be gained from group action. Abbott (1983) suggests extension programmes which teach farmers practical ideas on marketing are necessary to aid agricultural development. Negendank (1987) believes that since deregulation New Zealand farmers must become market led or suffer. As farmers are not organised to meet consumers wants and needs, there is a requirement for advisory services to assist farmers developing marketing strategies.

Other literature attempts to outline marketing management principles to farmers. For example a book edited by Bateman (1972) contains papers presented at a course on agricultural marketing for farmers. The course

encouraged farmers to accept the marketing concept and introduced marketing tools perceived to be useful for farmers. Cornelius (1988) describes how in his view, farmers should develop a successful marketing strategy. He thinks that a written marketing plan is essential for successful farmers. Nichols and Skewers (1987) provide worksheets for use in developing a marketing plan for corn producers. However their marketing plan is considerably simpler than a typical marketing plan found in business marketing literature, consisting of a budget analysis of sales alternatives for one crop.

Previous paragraphs clearly show that farmer marketing decisions are not limited to the sales considerations depicted in traditional agricultural marketing theory. The environment in which farm businesses operate is changing, in that farmers face a greater selection of management alternatives than in the past. Calls have been made for farmers to utilise more marketing management principles.

Initiators of these recommendations usually recognise the limitations farmers have in implementing marketing management concepts and base their reasoning on sound conceptual thinking. However some suggestions naively imply that farmers would benefit from directly copying the marketing management approaches outlined in business marketing theory. An extreme position taken by Blight (1984) suggests farmers should utilise marketing management techniques such as advertising. Blight examines concepts commonly accepted in the business marketing discipline and suggests they will work at the farm level. In a similar way, calls for farmer marketing education programmes and literature which shows farmers how to go about marketing must recognise the peculiar nature of farmer firms. Calls for farmer education in marketing management are not necessarily incorrect, however educational programmes must teach farmers concepts which are suitable for farmers, not other businesses.

Many farmers seem to recognise marketing management skills as a weakness in their management ability. For example a survey of Ontario farmers by Harling and Quail (1990) found that 78% were dissatisfied with their marketing management skills. It is unlikely that this problem would be confined to Ontario. While it seems inappropriate to suggest that farmers lack basic business skills or strategic capabilities, suggestions that business marketing principles should be incorporated at the farmer level need empirical or case study support. While seemingly sound in theory, the apparent lack of application suggests that these ideas may not work in practise.

Business marketing theory has developed from conceptual, empirical, and anecdotal research into the marketing activities that business firms undertake. Farm businesses to operate in conditions distinct from non-farm firms and although the differences between farm and other businesses may be narrowing, they must still be recognised. It is dangerous to naively view marketing management principles as the panacea for farmers problems without first examining if they will work at the farm business level. Farmers may face distinct problems which require separate remedies to those of other businesses. They may use approaches to marketing that are different but equivalent to those employed by non-farm businesses. With this in mind we will now examine empirical studies of the marketing strategies and tactics of farmers.

Empirical Studies of farmer marketing strategies and tactics:

Previous discussion highlights the need to explore empirical research which examines the marketing activities of farmers. Although the agricultural marketing discipline traditionally focuses on aggregate policy and distribution channel concerns rather then the marketing management problems facing individual farmers, a

small number of studies[3] describe farmer marketing activities at the business level. Other research attempts to identify optimal mixes of marketing variables. The following section briefly outlines these studies and comments on their limitations.

Table three summarises details of recent empirical research examining the marketing strategies and tactics of farmers. The farmer marketing management process involves managerial decision making with respect to the controllable marketing variables available. As the combination of a number of marketing activities are involved, research limited to the study of one marketing variable is not included in the table. For example studies which investigate sales activities using futures and hedging (eg. Karp, 1987; Shideed, et. al. 1987), or options (eg. Hauser and Eales, 1986). The table is divided into two parts containing research of a normative and positive nature. Each will be discussed in turn.

Normative research into the marketing strategies of farmers:

Normative studies use operations research techniques to find optimal combinations of a selected number of marketing variables. As marketing decisions are normally made with imperfect knowledge, most problems are stochastic in nature. Outcomes are not known with certainty, therefore risk is often incorporated into the objective function. Analytical approaches utilised include various forms of mathematical programming, risk analysis, and simulation (usually in combination with another approach).

Research of a normative nature which examines the marketing activities of farmers does not recognise the complex nature of the farmer marketing process and the interactions that may occur with a network of strategic variables. Often results are only applicable to the farm and time period being studied. Otherwise farm businesses are assumed to be members of relatively homogenous groups which only differ in risk preferences, or occasionally in the environmental conditions they face or resources they are endowed with. Business marketing researchers recognise the complex nature of the marketing process which is involved with human judgements and imperfect knowledge. They do not attempt to prescribe answers to complex marketing problems in the same way as studies which model the marketing behaviour of farmers.

No studies reviewed evaluate the full array of marketing activities which farmers undertake. Researchers continue to take the traditional viewpoint that marketing means sales. Therefore research is limited to analysis of a limited number of sales or disposition activities. It hypothesises that the marketing process involves selecting combinations of sales or disposition methods which gain the highest returns for produce. Results typically present optimal combinations of one or more marketing activity variables which include market outlet utilised, method of sale, timing of sale, and amount of produce to sell; sometimes at or during different discrete time periods.

Most studies assume that farmers are price takers and can only change their price by changing the method or timing of sale, or quantity of produce to sell at different time periods. However farmers produce is not totally homogenous. Although biological factors influence the quality of farmers produce, farmers have some control over the quality premiums or grades they obtain. Only one study reviewed, (Brennan and Hoffman 1989) evaluates the effects of changes in product quality.

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[3] Mainly in the agricultural economics and agribusiness journals. No research was found in the business marketing literature.

Table 3. Empirical Studies of the Marketing Strategies of Farmers:

Normative research:

Author	Farm type	Marketing activities	Analytical methods	Description
Bailey and Richardson (1985)	Cotton	9 combinations of cash and futures alternatives	Stochastic dominance	Evaluate alternative marketing strategies incorporating yield, quality, timing and price risk.
Anaman and Boggess (1986)	Mixed Crop	-cash sales at harvest -forward contracts at planting -hedging at planting -buying futures options at planting	Stochastic dominance	Determine optimal marketing strategies for farmers with different attitudes to risk
Berg (1986)	Wheat	Timing of sale	Dynamic programming and Monte Carlo simulation	Determine optimal timing of sale for wheat growers with different degrees of risk aversion.
Lambert et. al. (1986)	Wheat	Combinations of: -sale on cash market -future sale on cash market -future delivery cash contract	Discrete stochastic programming model	Determine marketing strategies which maximise expected net worth according to the utility function specified. Test if model approximates actual producers sales patterns.
Curtis et. al. (1987)	Soybeans	103 sales and timing of sales variations	Target MOTAD Linear programming	Determine risk efficient marketing mixes which minimise absolute negative deviations below a target return level
Zacharias et. al. (1987)	Soybeans	-preharvest forward -preharvest futures -cash at harvest plus date of contract and fraction of crop contracted	Stochastic dominance	Determine optimal risk efficient sets of preharvest soybean marketing strategies for Louisiana producers
Jensen (1988)	Cotton	55 sales alternatives	Stochastic dominance	Analyze marketing alternatives in order to develop a cotton marketing strategy that is best at a point in time
Rodriguez and Taylor (1988)	Cattle	-timing of sale plus optimal animal weight and animal density	Stochastic dynamic programming	Test the certainty equivalence property of sequential timing of sales and stocking densities, with stochastic steer prices and rainfall, for a Colorado cattle ranch under risky and riskless conditions.

Table 3. Empirical Studies of the Marketing Strategies of Farmers:

Normative research: (continued)

Author	Farm type	Marketing activities	Analytical methods	Description
Brennan and Hoffman (1989)	Cattle Corn Soybeans	Sell by Carcass Sell by live-weight plus type and quality of cattle and inputs utilised	Simulation Deterministic linear programming	Develop an interactive linear programming model to evaluate the effects of marketing alternatives, type of ration and feeding management practices on the relative profitability of producing feedlot cattle under midwestern conditions.
Groover et. al. (1989)	Cash grain	5 sales alternatives plus government and government programme alternatives	MOTAD linear programming	Provide optimal production and marketing strategies under different risk scenarios for a sample of four typical Eastern Virginia cash grain farmers in 1987.
Schroeder et. al. (1989)	Cattle	31 mixes of cash, futures, put option and call option alternatives	Stochastic dominance	Empirically identify optimal option hedging strategies for cattle feeders
Freeze et. al (1990)	Cattle	-cash sale -2 hedging options (each with and without participation in a government programme)	Target MOTAD Linear Programming	Identify optimal mixes of marketing variables depending on expected level of income and risk associated with each combination of activities
McKinnel et.al. (1990)	Soybeans	Thirty two sales methods and timing of sales combinations	Target MOTAD linear programming	Examine the average revenue and risk for a selected set of marketing strategies between 1972 and 1975, and compare results across three states
Garion et. al. (1990)	Calves and Yearlings	-timing of sale -number of cows to sell plus herd size	Stochastic dynamic programming	Give optimal decision rules according to price and the amount of standing crop available.
Schroeder and Featherstone (1990)	Cattle	-Cash -Hedged using futures and put options plus cow retention	Discrete stochastic programming	Determine optimal retention and marketing activities for cow-calf producers under different risk scenarios.
Tronstad (1990)	Wheat	Quantity of grain sold by cash and futures each month	Stochastic dynamic programming	Determine and analyze optimal grain marketing decisions depending on market conditions, the financial position of the firm, marketing constraints of the producer and participation in government programmes
Turvey and Baker (1990)	Corn Soybeans	-cash -futures -options -timing of sale	Two period discrete sequential stochastic programming	Model optimal use of futures, options and cash under alternative farm programmes with varying financial constraints

Table 3. Empirical Studies of the Marketing Strategies of Farmers:

Descriptive research:

Author	Farm type	Marketing activities	Analytical methods	Description
Fletcher and Terza (1986)	Wheat	-spot sale at harvest -sale after storage -contract sale	Maximum Likelihood multivariate probit analysis	Determine demographic and production characteristics of farmers, which correlate with farmers marketing decisions
Harwood et. al. (1987)	Corns	12 sales and storage alternatives	Little empirical analysis	Measure the proportion of Midwestern corn producers marketing and pricing corn using various alternatives
Carley et. al. (1988)	Peanuts	-cash marketing -centralised forward deliverable contracts -futures market exchanges -computer assisted exchanges -plus storage, drying, transportation, and pricing information	Probit analysis	Determine factors which influence the adoption of marketing alternatives for farmers of stock peanuts
Fu et. al. (1988)	Peanuts	-informal cash -informal contract -forward deliverable contract -futures -computerised	Multivariate probit (joint estimation)	Determine attitudes of peanut producers towards different marketing alternatives and describe their characteristics
Kwakyi et.al. (1989)	Peanuts	-private treaty market -futures market -formal forward contract -computerised market	Multivariate probit model	Assess stock peanut buyers and producers attitudes towards different market outlets and profile producer characteristics associated with different markets
Snyder (1989)	Cattle	-cattle age at sale -timing of sale -method of sale -market information utilised	Little empirical analysis	Survey Utah cattle producers marketing operations and perceptions of risk
Edleman et.al (1990)	Grain Hogs Feeder Cattle	-cash sale -forward contract -hedging -options	Maximum Likelihood Regression	Examine (1) the use of various forward pricing alternatives; (2) relationships among farm size, financial status, management indicators, policy preferences, and the use of various marketing alternatives (3) marketing information used by producers; and (4) producer reasons for not using forward pricing alternatives in the private sector

Marketing management theory suggests that production planning is an important part of the marketing process. Most research reviewed does not determine optimal product mix combinations. Farmers are assumed to have a pre-determined type of produce available for sale, therefore production planning is not modelled as part of the marketing process. Exceptions are Groover et al. (1989) who models the number of acres to sow

in various crops, as well as the sales methods which optimise returns for these crops. Freeze et. al. (1990) determine the number of cross breed and British feeder cattle to produce and sales activities to utilise.

Normative models which depict optimal marketing strategies for farmers are of only limited use in aiding actual farmers decision making. The complex procedures involved in implementing these models means they are not operational or economical enough to be useful for individual farmers (Malcom 1990). The distinctive competencies of farmer businesses, the environmental conditions they encounter and the goals of their owner operators are all likely to vary. These variations are not adequately portrayed in any of the research reviewed. Solutions presented are only appropriate for farmers who operate within the strict assumptions or conditions specified by the models.

Each study presents combinations of variables which maximise expected utility, measured in terms of short term returns and their variations. Marketing strategies employed in the real world are influenced by business goals[4]. It is possible that some farmers may sacrifice short term utility for longer term gains. Other farmers may attempt to maximise prestige by gaining higher crop yields or qualities than would maximise short term profit. Researchers who present mixtures of variables which maximise short term returns should realise that these solutions may differ from those which maximise farmers long term utilities. These studies present optimal tactics for maximising short term profits rather then optimal long term strategies.

Aggregate historical data is often used to determine optimal combinations of timing and method of sales variables. Often, solutions which maximise the expected value of returns are presented with no account taken of individual nature of farmer businesses. Research of this nature does not outline how optimal solutions may vary as the individual business characteristics change.

Other research models optimal behaviour for actual farms perceived to be typical for the industry and may be of only limited validity when applied to other farm businesses. To be useful, the separate constraints and objective functions of each farm business need to be incorporated into the models before they are solved. This is unlikely to be practical or economical in the real world.

Further research presents optimal solutions for typical groups of farmers who differ according to their risk preferences (in terms of variation in income or returns) or the environmental conditions they operate in (eg. discrete variations in rainfall, prices, taxes, interest rates, or financial conditions). However farmer businesses differ in more ways than this. For example distinctive competencies in areas such as management skills (human capital) are not recognised in any of the models, but are likely to influence the outcome of any marketing strategy a farm business may undertake. Descriptive studies recognise that different production and demographic characteristics are likely to correlate with farmers marketing decisions.

[4] Techniques such as goal programming may be able to be used to incorporate additional goals into the objective function (for an overview of goal programming see Romero 1986)

Descriptive studies of farmer marketing strategies and tactics:

Like normative studies, descriptive examinations of the marketing strategies and tactics of farmers take the view that marketing means sales. The descriptive studies summarised in table two analyze the utilisation of different marketing tactics, or producer attitudes towards alternative marketing outlets and activities. Like normative studies, they do not attempt to portray the complexity of the farmer marketing process, therefore many of the limitations outlined for normative studies apply. Some describe how different farmer or farm characteristics are associated with particular marketing tactics, and therefore show that certain types of farmers take different approaches to marketing. In the business literature reasons as to why these differences exist have been presented.

Business marketing theory has incorporated paradigms from strategic management and industrial organisational economics which suggest there are a limited number of unique combinations of strategic variables which businesses may utilise to gain competitive advantage. Each combination results in a distinctive pattern of strategic behaviour. These patterns of behaviour result in a distinctive business strategic focus which is likely to have different marketing implications. The strategic focus of businesses have been classified both conceptually (strategic typologies), and empirically (strategic taxonomies).

Neither positive or normative research acknowledges that different combinations of marketing activities may result from following different strategic typologies or taxonomies. Research which concentrates on a limited number of marketing variables does not attempt to delineate the sophistication of these strategies. Normative research presents unique maxima's, although the concepts of strategic typologies and taxonomies suggest that multiple solutions may be possible. The following discussion briefly outlines these concepts.

Strategic typologies and taxonomies:

Strategic typologies are usually conceptually (theoretically) derived across industry generalisations (Hambrick, 1984). The two most popular typologies are Porter's (1980) generic strategies and Miles and Snows (1978) strategic typologies; both of which have been subject to a great deal of investigation (eg. Hambrick, 1983; White, 1986; McDaniel and Kolari, 1987).

Porter (1980) outlines three conceptual typologies which a firm may use to gain sustainable competitive advantage. A *cost leadership* strategy requires firms to produce a low cost standardised product in order to attract price sensitive buyers. *Differentiation* strategies may be used to produce a product that appeals to buyers who are interested in elements other than price. Firms following a *focus* strategy attempt to fulfil the needs of a particular market segment by either cost leadership or differentiation. Porter suggests that any one of the three generic strategies may be successful, depending on the resources available to the business and the businesses distinctive competencies.

Miles and Snow (1978) categorise firms into four broad types; *defenders, prospectors, analyzers,* and *reactors*. Each differs on the basis of adaptive behaviour and general strategic orientation. The first three typologies are expected to enjoy success while the last is perceived to be a failure.

Strategic taxonomies are derived by empirically measuring the strategic focus of firms. Early research in this field includes contributions by Miller and Frieshen (1977), Miller, (1981), Galbraith and Schendel, (1983),

and Hawes and Crittenden (1984). A similar approach to these studies is taken by literature which studies strategic groups. A comprehensive review of the theory of strategic groups is given by McGee and Thomas, 1986. The concept of strategic groups was originally developed to explain intra-industry difference in profitability (Cool, 1985) and study the linkages between strategic behaviour and performance (Fahey and Christensen, 1986). More recently it has been used to derive intra industry groups of firms with a similar strategic focus (eg. Dess and Davis, 1984; Kim and Lim, 1988). Firms within strategic groups have common specific assets and make similar decisions with respect to key competitive strategy variables.

The peculiar nature of farmer firms means that it is unlikely that existing typologies adequately describe alternative strategic typologies at the farm business level. However casual observation suggests that successful farmers may pursue one of a number of strategies. A simple hypothetical example portrays four unique strategies which may exist in the farm sector. Farmers utilising a *cost minimisation* strategy would be likely to attempt to produce at the lowest possible cost. Another group of farmers may follow a *quality driven* strategy and focus on quality rather then production cost minimisation. They attempt to produce what the market wants with respect to quality. A farmer following a *product changer or switcher* strategy would actively seek opportunities for new products with higher returns and switch products or try new varieties in order to capture these high returns. A *boutique* strategy would involve vertical integration and high commitment to marketing. For example an organic farmer who sells produce to supermarkets or directly to consumers.

Each hypothetical strategy is the result of decisions made with respect to important strategic variables. The strategic focus most suitable for an actual farm business depends on the external conditions the farm business faces as well as internal business capabilities and constraints. Each strategic focus requires farm businesses to interact with the market in different ways. For example variations are likely to exist in the distribution channels utilised, the types and sources of information required, or businesses ability to adapt to changing environmental conditions.

Continuing empirical research at Lincoln University is identifying and describing strategic groups at the farmer level. Variables which indicate key strategic dimensions have been identified by surveying business and agricultural marketing, farm management, agricultural economics, industrial organisational economics and strategic management literature, and interviewing farmers and relevant academics. Empirical analysis to determine if strategic groups exist at the farm business level and the marketing strategies and tactics correlated with having a distinctive strategic focus is proceeding.

Summary:

This paper has shown that confusion exists with regard to the role of marketing management in agricultural marketing theory. Although the business and agricultural marketing disciplines have originated and developed from similar theoretical underpinnings, diversity currently exists between definitions of the disciplines, the theories they use to examine problems, and their subject matter. Unlike other branches of marketing such industrial, international, or services marketing; agricultural marketing has not developed the interdisciplinary marketing management approach of business marketing theory. Instead it continues to rely heavily on concepts that originate from economics and agricultural economics. Therefore agricultural marketing is usually recognised as a division of agricultural economics, not business marketing. Agricultural marketing continues to focus on aggregate distribution channel and policy issues rather then business level marketing

studies of individual firms.

This paper suggests that farmers utilise more sophisticated marketing strategies than the agricultural marketing literature portrays. The agricultural marketing discipline traditionally views marketing as a process that occurs after the product leaves the farm gate or with a change of ownership. Therefore farmer marketing decisions are limited to sales tactics. Empirical studies of the marketing activities of farmers do not depict marketing strategy as part of an integrated process with interfunctional relationships with other business operations and complex interactions between marketing variables. Suggestions that farmers should more actively utilise marketing management concepts, or are more actively involved in marketing management activities than is illustrated within agricultural marketing literature have little empirical backing. It is suggested that one method of evaluating the marketing behaviour of farmers is to search for alternative strategic approaches which farmers utilise. Continuing research with an empirical component is examining these issues. It will allow a greater understanding of the role of marketing management in agricultural marketing theory and producers marketing management behaviour.

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SOCIO-DEMOGRAPHIC CHARACTERISTICS OF U.S. CONSUMERS ASSOCIATED WITH THE SELECTION OF BEEF PRODUCTS: IMPLICATIONS FOR THE NEW ZEALAND BEEF INDUSTRY

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Abstract

The largest market for New Zealand beef is the United States. New Zealand exports more than three-fourths of its total beef exports to the U.S.. Little information is known, however, about the demographic and socio-economic characteristics of individuals in the U.S. who have eaten beef. Logit models are developed in this study to investigate the decision to eat beef products either away from home or at home. Factors significantly affecting the likelihood of eating beef include race, seasonality, urbanisation, ethnicity, household size, sex, age and income.

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Executive Summary

Little information is known about the demographic and socio-economic characteristics of individuals who have eaten beef in the United States. Models are developed, using the Individual Intake phase of the 1987-88 National Food Consumption Survey of the U.S. Department of Agriculture, to investigate the decision to eat beef products either away from home or at home. Factors significantly affecting the likelihood of eating beef include race, seasonality, urbanisation, ethnicity, household size, sex, age, and income. Results reveal that individuals on a special diet are less likely to eat beef than their corresponding counterparts. Furthermore, various socio-economic and demographic factors affect the likelihood of eating beef either away from home or at home. For instance, employed individuals are more likely to eat beef away from home but less likely to eat beef at home than unemployed individuals. In accord with prior expectations, household size is negatively related to the probability of eating beef away from home but is positively related to the likelihood of eating beef at home.

These results would be of significant interest to the following in New Zealand: the beef industry, meat exporting companies, the Trade Development Board, and the Meat Producers Board. Some implications for the New Zealand beef industry are drawn.

Introduction

On a per capita basis, beef and pork consumption in the U.S. from 1970 to 1988 fell 14 and 8 percent, respectively. However, per capita poultry and fish consumption rosed 66 and 27 percent, respectively. In 1955, beef consumption comprised about 39 percent of total U.S. meat consumption. During this same year, the shares of the total U.S. meat consumption of pork and poultry are 40 and 17 percent, respectively. However, in 1990, beef and pork consumption comprised only 31 and 27 percent, respectively while poultry consumption comprised 41 percent of the total U.S. meat consumption (Cothern).

These consumption trends indicate a shift in consumer demand away from beef and to white meat products. Factors that could have caused this consumption shift are changes in: tastes and preferences, relative prices of meat products, and dietary and health standards.

One of the most noticeable trends in U.S. consumers' food expenditure patterns in recent years is the growing proportion of income spent on food away from home (FAFH). In fact, the percentage of disposable income going to FAFH has increased from 5.5 percent in 1970 to 6.2 percent in 1989. In contrast, the percentage of disposable income going to food at home (FAH) has declined from 10.8 percent in 1970 to 7.6 percent in 1989. These economic trends point to the increasing importance of FAFH consumption relative to FAH consumption.

Changes in consumer demographics and lifestyles in the U.S. contribute to the increased popularity of FAFH. Some socio-

economic and demographic factors that come to mind: a growing number of women, married and single, in the work force; increasing importance of convenience in eating out; more families living on two incomes; the impact of advertising and promotion by large food service chains; and more people in the age group of 25 to 44 who are inclined to eat out often (Putnam and Van Dress). Only about seven percent of all households now fit the old stereotype family of a working husband, a wife who does not work for wages, and two children (Kinsey). Moreover, married couples with children are declining as a share of all households. The one-adult households are fastest growing and are likely to exhibit non-conventional food consumption patterns (i.e. FAFH consumption).

Majority of New Zealand's beef production (about 75 percent) is exported. In 1988, total beef and veal exports were worth over 950 million dollars. Over the period since 1970, beef and veal exports have made up approximately 40 percent of total meat exports by value (Sheppard, et al.). The largest market for New Zealand beef is the United States. In fact, over 70 percent of beef exports went to the U.S. since 1980. In 1989, about 76 percent of New Zealand's beef exports went to the U.S.. This figure reveals New Zealand's high dependence on the U.S. market for beef. Moreover, beef export earnings currently are as important to New Zealand as the combined export earnings of lamb and mutton (Harrison).

Little is known, however, about the demographic and socio-economic characteristics of individuals in the U.S. who have eaten beef either away from home or at home. Considering the

importance of the U.S. market to its exports, the New Zealand beef industry (including the meat exporting companies, Trade Development Board, and Meat Producers Board) would benefit from a study that would provide some information regarding the demographic and socio-economic profile of U.S. consumers who eat beef either away from home or at home.

This research attempts to fill these voids by using the Individual Intake phase of the 1987-1988 National Food Consumption Survey of the U.S. Department of Agriculture. This study attempts to identify, in a definitive fashion, the demographic and socio-economic characteristics of individuals in the U.S. who have eaten beef.

Literature Review

Several studies have been conducted recently to examine consumer attitudes and preferences toward meat products. Many of these studies examined consumer attitudes and preferences toward a particular meat product. Some of these studies are also geared toward determining the effect of leanness on consumer demand (e.g. Branson et al.; Skaggs et al.; Menkhaus et al.; Capps et al.). Many in the meat industry, particularly the beef and pork industries, believe that the recent downward shift in demand (i.e. beef, pork) can be ascribed to increased nutrition consciousness of consumers. Moreover, some industry executives also assert that consumer tastes and preferences changed away from beef and other red meats to white meats or toward less meat in general (Menkhaus, et al.).

In particular, Branson et al. examined the effects of

different degrees of leanness on consumer demand. Skaggs et al. analyzed the potential of marketing a branded, low fat, fresh beef product. Their findings show that consumers are receptive to beef products that are leaner and lower in fat. In 1988, Menkhaus, et al. identified factors which are important in influencing purchase and reorder decisions of a branded, low fat, fresh beef product using Logit regression technique. The results from their study indicate the importance of health related factors in influencing the decision to purchase leaner meats.

Capps, et al. identified several demographic and psychographic characteristics of consumers who buy lean meat products from a particular retail food chain in the U.S.. The results of the survey indicated that fat conscious consumers are more likely to buy lean meat products than to non-fat conscious consumers. Household size and the probability of buying lean meat products were positively related. There was, however, no statistically significant relationship between the likelihood of buying lean meat products and the price consciousness as well as the income class of consumers.

Several analyses have also been directed toward identifying the sources of structural changes in U.S. meat consumption (e.g. Nyankori and Miller; Braschler; Chavas; Moschini and Meilke). Furthermore, other studies have focused on the effect of demographic factors such as family size and composition on meat consumption (e.g. Buse and Salathe; Cox et al.; Blaylock and Smallwood; Lee). None of these studies, however, have examined the effect of socio-economic and demographic factors on the decision to purchase beef on either the away from home or the at

home market.

Conceptual Framework for the Analysis

This section presents the conceptual considerations and framework that are utilised to develop the empirical models. To investigate the decision to eat beef, logit analysis is used to estimate three models in which the likelihood of eating beef: (1)away from home, (2) at home, and (3) both away from home and at home is a function of a set of socio-economic and demographic variables. More information about logit analysis and the model specifications can be found in the appendix.

The analyses center on the hypothesis that a set of factors (variables) influence the decision to eat beef. These set of factors are as follows: urbanisation, region, race, ethnicity, sex, employment status, food stamp status, diet status, household size, age, income, time of week of consumption, and seasonality. These factors are described in Table 1.

Urbanisation is related to several variables like accessibility to diverse types of stores providing a wide variety of foods, differences in the social, cultural, and economic environment such as occupational opportunities and education, and the amount of information available to the individual. It is, therefore, hypothesised that individuals residing in central cities or suburban areas would have a higher probability of eating beef away from home due to the presence of numerous restaurants and fast food facilities than individuals residing in non-metro areas.

Table 1. Factors Used in the Analyses and their Description

Factor	Description
Urbanisation	whether the individual resided in a central city, suburban area, or non-metro area.
Region	whether the individual come from the Northeast, Midwest, West, or South
Race	whether the individual is white, black, Asian/Pacific Islander, or other race
Ethnicity	whether the individual is hispanic or not
Sex	whether the individual is male or female
Employment Status	whether the individual is employed or unemployed
Food Stamp status	whether the individual is a food stamp recipient or not
Diet status	whether the individual is on a special diet or not
Household size	number of people living in the individuals household.
Age	age of the individual in years
Income	annual household income
Time of Week of Consumption	whether the three-day intake of the individual occurred mostly during the weekend or weekday
Seasonality	whether the individual was surveyed during the first, second, third, or fourth quarter of the year

Race of the individual can affect the purchasing habits of individuals. However, no a priori hypothesis is specified about the impact of race on the likelihood of eating beef because race can be complicated by its relationship with other socio-economic and demographic characteristics. Males are expected to have a higher likelihood of eating beef either away from home or at home than females. Moreover, employed individuals are also expected to have a higher probability of eating beef away from home than unemployed individuals.

Individuals who are on special diet are hypothesised to have a lower likelihood of eating beef than those not on a special diet due to dietary and health concerns. As household size increases, it is hypothesised that the likelihood of individuals eating beef at home (away from home) would increase (decrease). Increases in income are expected to be associated with increases in the probability of consuming beef away from home. The probability of consuming beef away from home is also expected to be higher during the second quarter of the year due to Easter and other holidays than during the other three quarters.

Educational status of the individual is not included in the analyses because the data set provides information only on the educational status of male and female heads of the household. Likewise, household income, and not individual income, is provided by the data set.

Three different models are developed to determine the likelihood of eating beef: (1) away-from-home (referred to in the text as the FAFH model); (2) at-home (referred to in the text as the FAH model); (3) both away-from-home and at-home (referred to

in the text as the all food model). The details of the model specification and the definitions of the variables used in the analyses are exhibited in the appendix.

Data Source and Description

The data set used in this study is the Individual Intake phase of the 1987-88 National Food Consumption Survey from the United States Department of Agriculture. This data set is the most recent of the national household food consumption surveys conducted by USDA.

As in any cross-sectional study, several issues arise in handling the data set. The original number of respondents in the survey is 11,045. However, several individuals in the sample have incomplete socio-economic and demographic information. Subsequently, after deleting observations with missing individual relevant socio-economic and demographic information, the data set contained 6276 observations.

The descriptive statistics of the independent variables used in the regression analyses are exhibited in Table A.1 in the appendix. About 21 percent of the sample reside in central city areas; 49 percent in suburban areas; and 30 percent in nonmetro areas. Roughly 35 percent of individuals included in the sample come from the South. Eighty six percent are white; 96 percent are non-Hispanic; 45 percent are male; 58 percent are employed; 95 percent are non-recipients of the food stamp program; 14 percent are on a special diet; and about 16 percent ate food mostly on a weekend during the three-day survey period. Moreover, the average age of the individuals is about 43 years

while the average household size is approximately three. Average household annual income is close to $30,000.

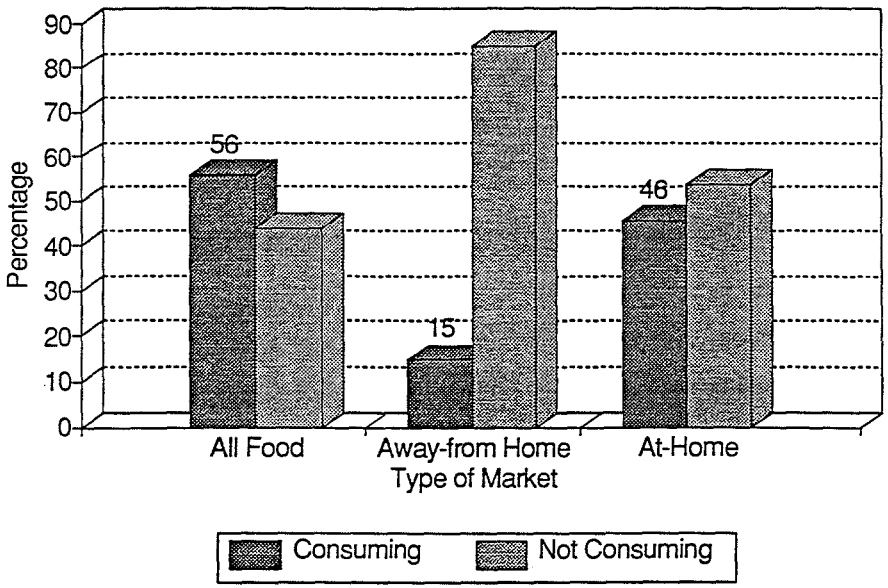
Fifty six percent of the individuals in the sample consumed beef (from both the away from home and at home markets). About 15 percent consumed beef away from home and about 46 percent consumed beef at home (see Figure 1).

Empirical Results

The results of the all food model show that the race and the seasonal variables significantly affect the probability of eating beef. In particular, blacks are less likely to eat beef than whites. The likelihood of eating beef is lower (higher) during the first and fourth quarters (third quarter) than during the second quarter of the year. In terms of region, individuals from the Northeast are less likely to eat beef than individuals from the South. Interestingly, individuals residing in non-metro areas are more likely to eat beef than individuals residing in either central cities or suburban areas. Hispanics are more likely to eat beef than non-Hispanics. The probability of eating beef is also higher for males than for females.

Results also reveal that food stamp recipients are less likely to eat beef than non-food stamp recipients. Moreover, those on a special diet are less likely to eat beef than those not on any kind of special diet. This result may have some important implications about consumers nutritional perception of beef. Other variables significantly affecting the probability of

Figure 1. Percentage of Individuals Consuming or Not Consuming Beef



eating beef are the following: household size, age, and income.

The results of the FAFH and FAH models indicate that individuals residing in central cities or suburban areas are significantly less likely to eat beef at home but not away from home than individuals residing in non-metro areas. Individuals from the Northeast and the West, however, are less likely to eat beef away from home than individuals from the South. Whites are more likely to eat beef in both the away from home and at home markets than blacks and are more likely to eat beef at home than Asians/Pacific Islanders. The seasonality variables, as a group, are significant factors in the FAH model but not in the FAFH model. In general, the likelihood of eating beef at home is higher (lower) in the third quarter (first quarter) than in the second quarter.

Hispanics are more likely to eat beef at home than non-hispanics. Males, on the other hand, have a higher likelihood of eating beef in both the away from home and at home markets than females. Interestingly, employed individuals are more likely to eat beef away from home but less likely to eat beef at home than unemployed individuals. Food stamp recipients and individuals who are on a special diet, on the other hand, are less likely to eat beef at home than their counterparts. In accord with prior expectations, household size is negatively related to the probability of eating beef away from home but is positively related to the probability of eating beef at home. Age is generally positively related to the likelihood of eating beef at home but not away from home. Income is positively related to the likelihood of eating beef away from home. In addition,

individuals who consumed their food mostly during a weekend are more likely to eat beef away from home than individuals who consumed their food mostly during weekdays.

The statistical estimates of all the models are found in Tables A.2 to A.4 in the Appendix.

Implications for the New Zealand Beef Industry

Table A.5 and Figures 2, 3, and 4 present the beef and veal shipments to the U.S. from 1980 to 1989. As shown, over 70 percent of beef exports went to the U.S. since 1980. In 1989, about 76 percent of New Zealand's beef exports went to the U.S.. This figure reveals New Zealand's high dependence on the U.S. market for beef. Beef export earnings currently are as important to New Zealand as the combined export earnings of lamb and mutton (Harrison). The second largest market is the domestic New Zealand market taking about 23 percent of total beef production.

Although New Zealand exports about three fourths of its total beef exports to the U.S., this figure only represents 2.5 percent (on a carcase weight equivalent basis) of the total beef consumed in the United States. The U.S. Meat Import Law acts as a deterrent in preventing large amounts of New Zealand produced beef from entering the U.S. market. Although actual quotas have not been set since 1976 (Cothern), voluntary restraints have been imposed on beef imports into the U.S. market. However, there might still be some room for further expansion of exports to the United States because of the expected increase in U.S. meat imports in the next few years. Furthermore, Australian cattle numbers are expected to decrease by as much as 20 percent this

Figure 2. New Zealand Beef and Veal Exports to the U.S. by Volume (1980-89)

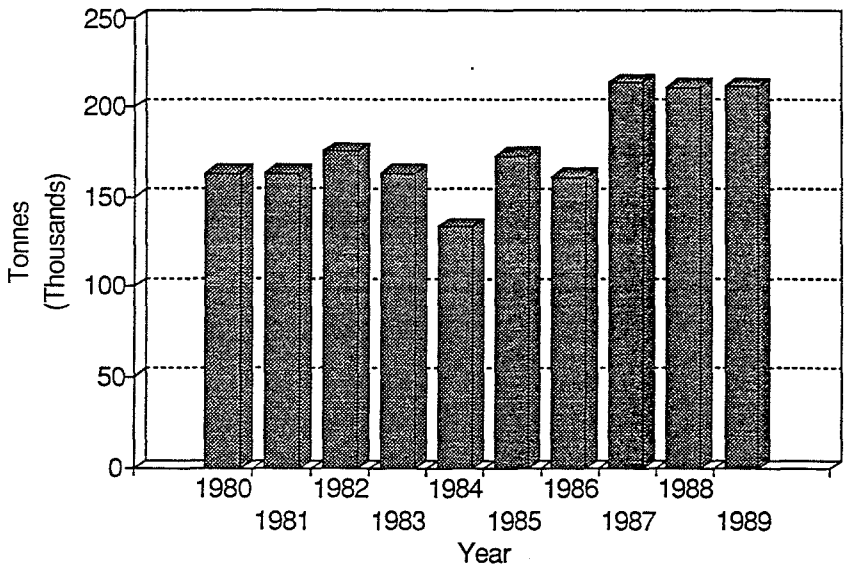


Figure 3. New Zealand Beef and Veal Exports to the U.S.: % of Total Exports

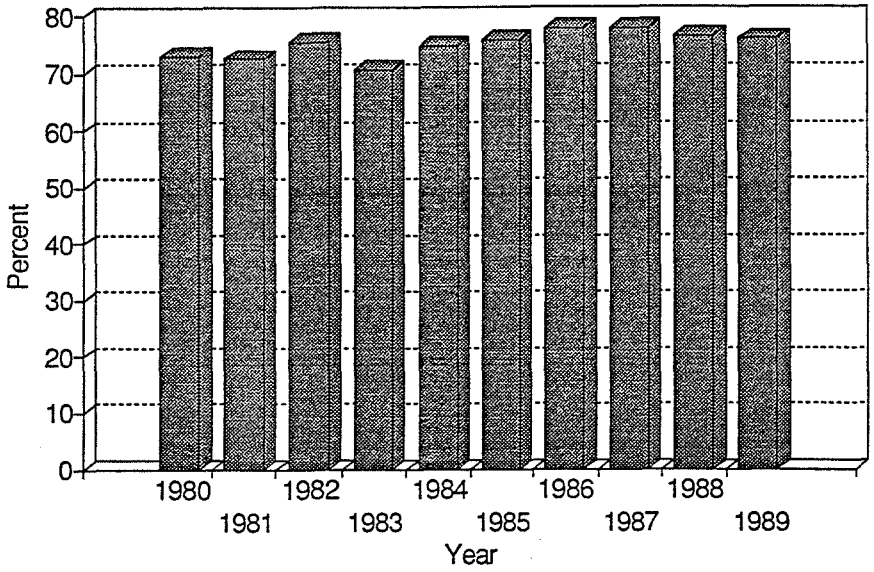
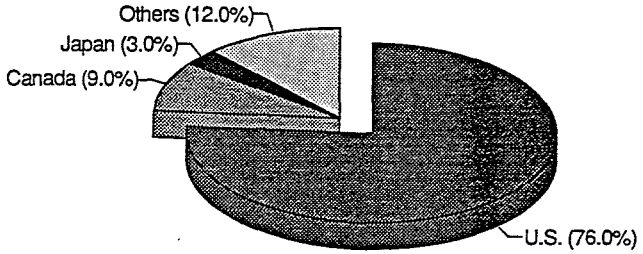


Figure 4. New Zealand Beef and Veal Exports: Country of Destination (1990)



year because of drought.

Most of the beef exported to the U.S. is destined for grinding particularly because of its leanness and suitability to this end use in manufactured beef products. While the majority of beef produced in the United States is grain fed beef, New Zealand produces grass fed beef which is generally leaner or lower in fat content. The leanness of New Zealand beef is relevant especially since the results of this study indicate that U.S. consumers on a special diet are less likely to eat beef than those not on a special diet. Moreover, as indicated by previous studies, U.S. consumers are still receptive to beef products that are leaner and lower in fat (Branson et al.; Skaggs et al.). In 1988, Menkhaus et al. revealed the importance of health related factors in influencing the decision to purchase leaner meats. Capps, et al. also revealed that fat conscious consumers are more likely to buy lean meat products than non-fat conscious consumers.

Most of the grass-fed beef products is used in the fast food and retail industries as ground beef. Additionally, the prospect for an increasing demand for lean beef has been bolstered by the introduction of lean burgers in fast food chains (i.e. McDonalds, Hardee's). Hence, the U.S. beef market, even with the existence of the U.S. Meat Import Law, cannot ignore changes in competitive pressures in the fast food and retail industries (Cothern). Basing from these developments, it is therefore important that the New Zealand beef industry work closely with selected end users to develop particular market segments for lean or grassfed beef, in both the U.S. retail and restaurant sectors. The New

Zealand beef industry could capitalise on these concerns by branding product lines and promoting those lines as being separate and different from generic beef products. Moreover, the industry should exploit New Zealand beef's clean, safe image in the promotion of its products in the U.S..

The results of this study also indicate that employed individuals are more likely to eat beef away from home but less likely to eat beef at home than unemployed individuals. This finding is in accord with prior hypothesis that individuals with higher opportunity cost of time (e.g. employed individuals) are more likely to eat beef away from home than those with lower opportunity cost of time (e.g. unemployed individuals). This result is consistent with the current trend in the U.S. of increasing demand for convenience foods. The development of convenience beef products that cater to working men and women not only in the U.S., but also in New Zealand would be another way to add value to the New Zealand primary beef product.

Conclusions

Models were developed to investigate the decision to eat beef. These models provided a profile, in terms of the socio-demographic characteristics, of individuals in the U.S. who were more likely to eat beef either away from home or at home. The identification of these types of consumers is essential in analysing consumption behaviour and developing specific marketing programmes. Consequently, this information should aid market analysts focus their efforts on the group of consumers less likely to eat beef either away from home or at home. Hopefully,

the results of these analyses would be of significant interest to not only the food distribution and food service industries but to the New Zealand beef industry as well.

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APPENDIX

Table A.1. Descriptive Statistics of the Independent Variables Used in Analysis

Variable	Mean	Std. Dev.	Range
Urbanisation			
Central City	0.21	0.4044	0-1
Suburban Area	0.49	0.5000	0-1
Non-metro Area[a]	0.30	0.4567	0-1
Region			
Northeast	0.20	0.3997	0-1
Midwest	0.27	0.4452	0-1
South[a]	0.35	0.4762	0-1
West	0.18	0.3843	0-1
Race			
White[a]	0.86	0.3380	0-1
Black	0.10	0.2970	0-1
Asian/Pacific Islander	0.01	0.0906	0-1
Other race	0.03	0.1571	0-1
Origin			
Hispanic	0.04	0.1855	0-1
Non-Hispanic[a]	0.96	0.1855	0-1
Sex			
Male	0.45	0.4968	0-1
Female[a]	0.55	0.4968	0-1
Employment Status			
Employed	0.58	0.4935	0-1
Unemployed[a]	0.42	0.4935	0-1
Food Stamp Participation			
Recipient	0.05	0.2219	0-1
Non-recipient[a]	0.95	0.2219	0-1
Special Diet			
Yes	0.14	0.3495	0-1
No[a]	0.86	0.3495	0-1

Table A.1 cont.

	Mean	Std. Dev.	Range
Week Variable			
Weekend	0.16	0.3682	0-1
Weekday[a]	0.84	0.3682	0-1
Seasons			
Quarter1	0.29	0.4554	0-1
Quarter2[a]	0.41	0.4899	0-1
Quarter3	0.14	0.3508	0-1
Quarter4	0.16	0.3689	0-1
Age	43.30	18.37	15-99
Household Size	3.03	1.46	1-12
Income	29621.80	23927.8	3-300000

[a]Refers to the omitted category in the analysis.

Table A.2. Maximum Likelihood Estimates of the Logit Model for Beef (All Food Model)

Variable	Estimate	Std. Error	Changes in Probability[a]
Intercept	-1.478*	0.422	-0.364
Urban1	-0.134*	0.075	-0.033
Urban2	-0.146*	0.063	-0.036
Region1	-0.157*	0.075	-0.038
Region2	-0.097	0.069	-0.024
Region4	-0.103	0.077	-0.025
Race2	-0.339*	0.095	-0.083
Race3	-0.367	0.284	-0.091
Race4	-0.047	0.186	-0.011
Hisp1	0.464*	0.162	0.114
Sex1	0.269*	0.053	0.066
Employ1	-0.046	0.057	-0.011
Fstamp1	-0.238*	0.126	-0.058
Diet1	-0.160*	0.075	-0.039
Hsize	0.100*	0.020	0.024
Logage	0.217*	0.065	0.001
Logincome	0.075*	0.034	0.62-06
Weekend	0.137*	0.071	0.034
Quarter1	-0.118*	0.062	-0.029
Quarter3	0.234*	0.080	0.057
Quarter4	-0.148*	0.075	-0.036

Percentage of right predictions -	57.3
R Statistic	0.1120
McFadden R^2	0.0171
Likelihood Ratio Tests	
Urbanisation	5.84
Region	4.95
Race	13.89*
Season	22.23*
Number Of Iterations	5
Ratio[b]	0.5560

* Indicates statistical significance at the 0.05 level
[a]Equal to the product of the parameter estimates times the value of the logistic density function. At the sample means, the value of this density function (f(z)) is 0.2467 while the value of z is 0.2298.
[b]Ratio of nonzero observations to the total number of observations (6276).
Note: The R statistic is similar to the multiple correlation coefficient in the normal setting, after a correction is made to penalize for the number of parameters estimated. See page 183 of the SUGI supplemental guide, 1983 edition of SAS for further details.

Table A.3. Maximum Likelihood Estimates of the Food Away from Home Logit Model for Beef

Variable	Estimate	Std. Error	Changes in Probability[a]
Intercept	-2.263*	0.610	-0.274
Urban1	0.136	0.105	0.016
Urban2	-0.022	0.089	-0.003
Region1	-0.212*	0.106	-0.025
Region2	-0.066	0.094	-0.007
Region4	-0.188*	0.107	-0.022
Race2	-0.447*	0.152	-0.054
Race3	0.197	0.375	0.024
Race4	0.196	0.257	0.023
Hisp1	-0.057	0.224	-0.007
Sex1	0.346*	0.073	0.041
Employ1	0.275*	0.082	0.033
Fstamp1	-0.020	0.209	-0.002
Diet1	0.004	0.109	0.0005
Hsize	-0.158*	0.029	-0.019
Logage	-0.293*	0.091	-0.0008
Logincome	0.186*	0.051	0.76-06
Weekend	0.217*	0.093	0.026
Quarter1	-0.116	0.087	-0.014
Quarter3	-0.105	0.112	-0.013
Quarter4	-0.179*	0.107	-0.021

Percentage of right predictions -	85.1
R Statistic	0.1350
McFadden R^2	0.0260
Likelihood Ratio Tests	
Urbanisation	2.77
Region	5.47
Race	10.47*
Season	3.58
Number of Iterations	5
Ratio[b]	0.1487

*Indicates statistical significance at the 0.05 level
[a]Equal to the product of the parameter estimates times the value of the logistic density function. At the sample means, the value of this density function (f(z)) is 0.1209 while the value of z is -1.8087.
[b]Ratio of nonzero observations to the total number of observations (6276).
Note: The R statistic is similar to the multiple correlation coefficient in the normal setting, after a correction is made to penalize for the number of parameters estimated. See page 183 of the SUGI supplemental guide, 1983 edition of SAS for further details.

Table A.4. Maximum Likelihood Estimates of the Food at Home Logit Model for Beef

Variable	Estimate	Std. Error	Changes in Probability[a]
Intercept	-1.734*	0.425	-0.431
Urban1	-0.201*	0.075	-0.050
Urban2	-0.168*	0.062	-0.041
Region1	-0.104	0.075	-0.025
Region2	-0.070	0.068	-0.017
Region4	-0.061	0.076	-0.015
Race2	-0.271*	0.096	-0.067
Race3	-0.651*	0.302	-0.161
Race4	-0.239	0.183	-0.059
Hisp1	0.425*	0.157	0.105
Sex1	0.179*	0.052	0.044
Employ1	-0.183*	0.057	-0.045
Fstamp1	-0.236*	0.128	-0.058
Diet1	-0.140*	0.076	-0.034
Hsize	0.162*	0.020	0.040
Logage	0.292*	0.065	0.001
Logincome	0.025	0.034	0.21-06
Weekend	0.079	0.070	0.019
Quarter1	-0.118*	0.062	-0.029
Quarter3	0.291*	0.079	0.072
Quarter4	-0.090	0.075	-0.022

Percentage of right predictions - 57.1

R Statistic	0.1220
McFadden R^2	0.0195
Likelihood Ratio Tests	
Urbanisation	9.54*
Region	2.21
Race	13.39*
Season	26.68*
Number Of Iterations	5
Ratio[b]	0.4603

* Indicates statistical significance at the 0.05 level
[a]Equal to the product of the parameter estimates times the value of the logistic density function. At the sample means, the value of this density function (f(z)) is 0.2483 while the value of z is -0.1628.
[b]Ratio of nonzero observations to the total number of observations (6276).
Note: The R statistic is similar to the multiple correlation coefficient in the normal setting, after a correction is made to penalize for the number of parameters estimated. See page 183 of the SUGI supplemental guide, 1983 edition of SAS for further details.

Table A.5. New Zealand Beef and Veal Exports to the U.S., by Volume

Year (September ending)	Volume[a]	Percent of Total Exports
1980	164,056	72.9
1981	163,726	72.5
1982	176,426	75.3
1983	163,888	70.4
1984	133,871	74.8
1985	173,641	75.7
1986	161,942	77.6
1987	214,200	77.8
1988	211,033	76.4
1989	212,138	75.8

Source: New Zealand Meat Producers Board
[a]In tonnes.

Logit Analysis

Since the dependent variables are discrete (binary), these analyses rely on the use of qualitative choice models. The linear probability model, the probit model, and the logit model are the alternative specifications of qualitative choice models (Pindyck and Rubinfeld). The linear probability model is given by:

$$Y_i = X_i'B + E_i$$

where Y_i is 1 if the ith decision maker selects the first alternative and 0 if the ith decision maker selects the second alternative; X_i' is the ith row of the nXp matrix of regressors, i= 1, ..., n (n refers to the sample size and p refers to the number of coefficients); B is a pX1 vector of parameter coefficients; and E_i is the ith independently and identically distributed random variable with zero expectation.

Logit and probit analyses, however, are preferred to the linear probability model when qualitative choice models (e.g. discrete/binary dependent variable) are to be estimated since the latter suffers from a number of deficiencies. The variance of the disturbance term of the model is heteroskedastic and, therefore, the standard errors of the ordinary least squares parameter estimates are biased. Further, the disturbance term is not normally distributed. The classical statistical tests are then not applicable. Another deficiency of the linear probability model is that it allows the predicted values (probabilities) to fall outside the interval between 0 and 1, which is inconsistent with the interpretation of the conditional expectation as a probability.

A logit or probit specification circumvents these difficulties of the linear probability model via the use of monotonic transformations to guarantee that predictions lie in the unit interval. Logit models are employed in the analyses to circumvent the inadequacies of the linear probability model and because of the dichotomous nature of the dependent variables that are used. These models are based on the cumulative logistic probability function and are specified as (Pindyck and Rubinfeld):

$$P = F(Z) = F(X_i'\beta) = 1/(1+e^{-Z}) = 1/(1+e^{-(Xi'\beta)})$$

where Z is a theoretical index determined by a set of explanatory variables X; F(Z) is the cumulative logistic function; e represents the base of natural logarithms (approximately equal to 2.718); and P is the probability that an individual will make a certain choice, given the knowledge of X;

The most suitable technique of estimation when using logit is maximum likelihood. Although this technique requires the use of iterative algorithm, this procedure assumes the large-sample properties of consistency and asymptotic normality of the parameter estimates so that conventional tests of significance are applicable.

Model Specification

The logit models are specified as follows:

$$PROB=b_0 + b_1urban1 + b_2urban2 + b_3region1 + b_4region2 + b_5region4 + b_6race2 + b_7race3 + b_8race4 + b_9hisp1 + b_{10}sex1 + b_{11}employ1 + b_{12}fstamp1 + b_{13}diet1 + b_{14}hsize + b_{15}logage + b_{16}logincome + b_{17}weekend + b_{18}quarter1 + b_{19}quarter3 + b_{20}quarter4;$$

where PROB represents the following dependent variables:
(1) equal to 1 if the individual consumed beef away from home and 0 otherwise (referred to in the text as the FAFH model);
(2) equal to 1 if the individual consumed beef at home and 0 otherwise (referred to in the text as the FAH model); or
(3) equal to 1 if the individual consumed beef away from home and at home and 0 otherwise (referred to in the text as the all food model).

The independent variables refer to the following:
urban1 = 1 if individual resides in a central city; 0 otherwise;
urban2 = 1 if individual resides in a suburban area; 0 otherwise;
region1 = 1 if individual is in the Northeast; 0 otherwise;
region2 = 1 if individual is in the Midwest; 0 otherwise;
region4 = 1 if individual is in the West; 0 otherwise;
race2 = 1 if individual is black; 0 otherwise;
race3 = 1 if individual is Asian or Pacific Islander; 0 otherwise;
race4 = 1 if individual is of some other race; 0 otherwise;
hisp1 = 1 if individual is hispanic; 0 otherwise;
sex1 = 1 if individual is male; 0 otherwise;
employ1 = 1 if individual is employed; 0 otherwise;

fstamp1 = 1 if individual is receiving food stamps; 0 otherwise;
diet1 = 1 if individual is on a special diet; 0 otherwise;
hsize = household size;
logage = the logarithm of age;
logincome = the logarithm of income;
weekend = 1 if the three-day intake of the individual occurred mostly during a weekend; 0 otherwise; and
quarter1, quarter3, and quarter4 = correspond to a set of binary variables that measure seasonality, (qaurter1=1 if January - March; quarter3=1 if July-September; quarter4=1 if October-December) (reference category, April-June).

One classification is eliminated from each group of variables for estimation purposes. The base group are individuals who satisfy the following description: reside in a nonmetro area (urban3); in the South (region3); white (race1); nonhispanic (hisp2); female (sex2); not employed (employ2); not participating in the food stamp program (fstamp2); not on a special diet (diet2); and the three-day intake occurred mostly during a weekday (weekday). The analyses are separated into three different food sources: FAFH, FAH, and all foods eaten to determine if different factors affect the likelihood of eating beef across these three food sources.

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ETHICS, ECONOMICS AND INFORMATION MARKETS

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ABSTRACT

The failure of the business ethics literature to adequately reconcile ethics with the economic model necessitates further study in this area. Examining ethics from the producer's viewpoint with regards to the ethical content of the goods they supply to consumers, brings us into the arena of information markets. It is expected that advertising levels and the information on a good's ethical characteristics will vary with the type of good supplied and the verifiability of information provided. The levels of advertising and the type of information conveyed is expected to have changed over time, just as ethical standards and ethical perceptions have changed. If insufficient data exists, a case study in an industry (such as the fur or egg industry) which uses animals will be used to investigate these ideas.

[A] BUSINESS ETHICS

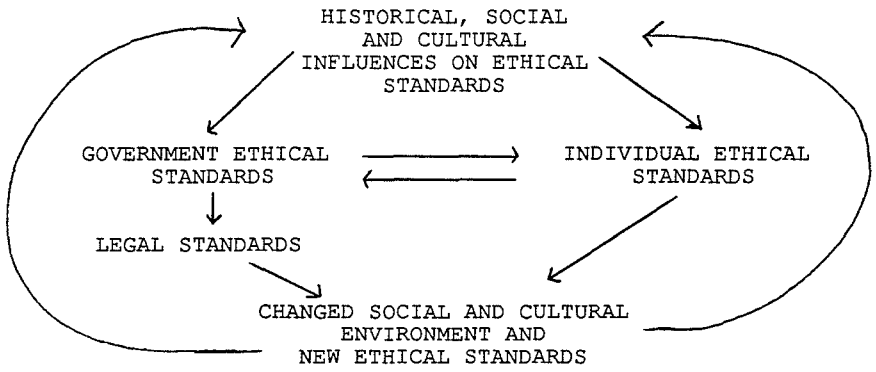
Ethics are value-systems based upon individuals', groups', and societies beliefs of what constitutes right and wrong. Since value-systems differ between individuals', groups', and societies', ethics must be regarded as subjective. As Lewis (1985) put it: Defining business ethics [is] like nailing jello to a wall". Therefore, any decisions upon what constitutes, for example, an ethical or unethical product in this study, are necessarily from my own personal value-system, since reaching a consensus would otherwise be difficult if not impossible.

There is a substantial literature on business ethics, the majority of which fails to offer precise definitions of the terms used. Authors often assume that their readers share a consensual definition of ethics and therefore fail to define the term in their writings (Lewis, 1985). This practice persists despite the recognition that no true consensus on ethics exists between individuals and groups either nationally or internationally (Lewis, 1985; Stevens, 1984; Friedman, 1980; Spencer and Butler, Jr., 1987).

The basic difficulty all writers face is that the subjective nature of business ethics precludes generalised definitions, although most writers offer these. For example, Arlow and Urlich (1980, p21), split the field into personal ethics (commitment to personal integrity and honesty in business) and social responsibility (individual accepting responsibility for the social effects of their business decisions). Lewis (1985, p381) believes "'business ethics' [are] the rules, standards, codes, or principles which provide guidelines for morally right behaviour and truthfulness in specific situations". Hosmer (1984, p315) sees business ethics as being above "normal personal obligations to speak the truth and observe the law"; while Hattwick (1986) draws a distinction between ethical duties (eg observing the law) and ethical ideals. (eg the Christian ideal)

Ethical duties and ideals are influenced by the cultural setting, and are subject to change over time, as technological, economic and political change occurs within that society. (See figure one).

FIGURE ONE
FORMATION OF ETHICS WITHIN A SOCIETY



These influences flow on to the legal environment which sets acceptable standards for the different industries which operate in a country. The fact that these may be perceived as ethical standards is not questioned by any authors', and the across the board application is seen as equalising the costs firms face in fulfilling the requirements of the law. However, the growth of organisations has seen the question of business social responsibility become an issue usually perceived as the firm's individual response to ethics (Vogel, 1991). As with ethics, business social responsibility is also value-laden and open to personal interpretation (Spencer and Butler, Jr., 1987). Authors have argued various aspects of BSR but the major contention is from an economic aspect.

One view argues that businesses responsibility is to generate wealth, not give it away (Barach and Elstrott, 1988; Drucker, 1987); while another view is that BSR is not philanthropic due to the fact businesses expect a return from their behaviour (Vogel, 1991). Reilly and Kyj (1990) believe that the economic requirements of efficiency and profit-maximisation and ethics are mutually exclusive; while other authors specifically see the areas as interrelated (Spencer and Butler, Jr., 1987; and McGuire (1963) and Davis (1960) in Spencer and Butler, Jr., 1987).

In effect, much of the literature in this field is conjecture about the way in which society and businesses interact to implement ethical standards set by law and the personal ethical standards of economic agents.

[B] ETHICS AND THE ECONOMIC MODEL

The existing legal standards and economic agents' utility functions are the mechanisms by which ethics will enter the economic as opposed to the 'business' model. The ethical standards set down by law will be reflected in the business environment (presumably affecting all companies it relates to equally), as will any beliefs people hold about ethical standards above those specified by law.

Ethical standards over and above legal requirements enter the model in two ways:

(1) Through a consumer's demand function: do they purchase or not purchase?, and

(2) Through a producer's supply function: do they supply or not supply?

Producers' supply may be a response to consumer demand or may be innovative. In either case, producers must meet set legal standards which are the same for all producers. However, beyond this we move into ethical standards which relate to an individual producer's value-system. If a producer adopts ethical standards higher than the legal requirements, their costs will rise, and there is not necessarily any guarantee that higher revenue will be generated. On the other hand, in some cases (for example branded items), a premium price and profit is believed to be achievable, although the additional profit is expected to be spent on advertising (Klein and Leffler, 1981).

On a technical level the issue of profit-maximising or profit-satisficing arises. While debate does exist over the realism of profit-maximising (see for example Naylor and Vernon, 1969; Berle and Means, 1967), the prevalence of the profit-maximising assumption in the literature (for example, Henderson and Quandt, 1980; Baumol, Blinder, Gunther and Hicks, 1988; Parkin, 1990; Schleifer and Vishney, 1987) and the lack of specificity of profit-satisficing as a viable long-term means of operation, leads profit-maximisation to be the assumed producer behaviour.

[C] PRODUCER VERSUS CONSUMER ETHICS

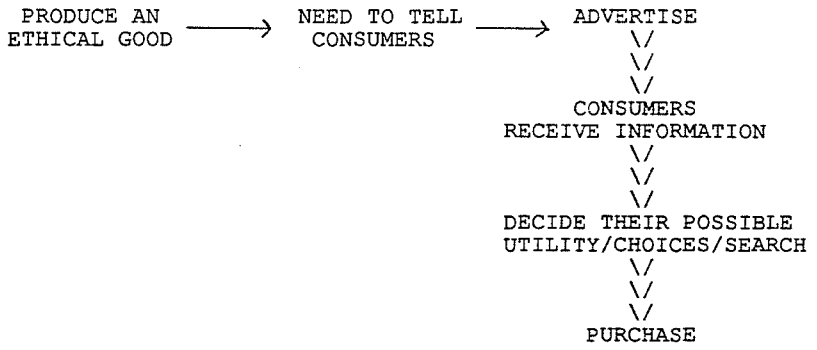
It is possible to study ethics from three perspectives: legal, demand- or supply-side. The producer perspective has been chosen due to the central position the producer holds in the marketplace in relation to ethical products. On the one hand,

producers may be innovators of an ethical product, or may respond to consumer demand. Producers can not ignore consumers perceptions of a good's ethical content. For example, the fur industry, the move towards animal rights, the use of cattle hormones to boost meat production, and the whole 'green' movement in general, force producers to meet the changing ethical standards of consumers. Consumers perceptions will be of interest to the producer and after adapting their products to be ethically desirable they will want to convey this information to both current and prospective clients. To communicate with consumers' in the marketplace, producers' utilise information markets.

Therefore we can develop figure two:

FIGURE TWO

PRODUCERS' USAGE OF INFORMATION MARKETS



Producers must produce goods with given legal requirements but may adopt ethical standards above these. In the situation where ethical standards are above those required by law, it is believed that this will be communicated to consumers in order to ensure that revenue as well as costs are raised, although they will still aim to minimise their costs, given profit-maximising behaviour. Information markets are therefore a key to understanding ethics and the producer.

[D] INFORMATION MARKETS

Consumers' face a multitude of choices in their decisions to buy goods and services and have search costs in obtaining information by which to determine their choices (where search costs are defined by Stigler [1961] as the process of ascertaining the best available price of a good over a range of options). Benham (1972) and Nelson (1970, 1974) believe advertising is an effective way to give consumers information and reduce search costs. All information, be it a sign at the supermarket or dairy to a magazine advertisement to a television campaign, is a form of advertising, and this has lead to a search of the advertising literature.

[E] THE ADVERTISING LITERATURE

Before discussing advertising further, it is necessary to briefly point out three types of goods Davis, Kay and Star (1991), Ward, Chang and Thompson (1985) and Nelson (1970, 1974) amongst others, refer to.

The first type of good is considered a search good, so called because the literature believes their properties can be completely ascertained before purchase (for example, jewellery). It is advanced by Davis et al (1991) that this group will be advertised lightly because providing false or exaggerated information will be immediately verifiable and therefore unlikely to be believed by the consumer.

Secondly, we may define experience goods, where it is proposed that some usage of the good is necessary to know whether the information provided by the supplier is true, and whether it meets the consumer's expectations. This category is broken down into short-term experience goods and long-term experience goods.

A short-term good needs at least one try to ascertain the truth of the advertised information. An example would be canned fruit. If a can of pears is advertised as containing six halves then one must purchase the can and open it to decide whether the advertising statements are true.

A long-term good needs several tries to ascertain the truth of it's advertisement. An example of a long-term good would be anti-dandruff shampoo, where more than one usage is needed to find out whether it will cure the consumer's dandruff.

Davis et al (1991) expect that short- and long-term experience goods have high advertising content.

Thirdly, we may define credence goods, items where experience is believed to be of little value either because the good is too technical (eg a washing machine) or so expensive that purchase is infrequent (eg a dishwasher). (Ford, Smith and Swasy, 1990; Davis et al, 1991). It is advanced by Davis et al (1991) that these goods will have low levels of advertising.

As pointed out above, all three types of goods (search, experience and credence goods) are all expected to be advertised to some extent. It is only worth producing a good with ethical standards above the norm if there are consumers who value this, want the information given and buy the product offered. Therefore advertising can provide information to consumers by making them aware of choices that are available which can fulfil their ethical expectations. The literature terms this a competitive view of advertising, because advertisements are believed to impart information and reduce search costs. There is however an opposing notion that advertising is anti-competitive, in that it raises barriers to entry for new or potential market entrants. This view would still allow for the transfer of information on ethical goods to consumers', and may therefore be incorporated into the discussion.

THE COMPETITIVE VIEW

One set of writers believe that advertising is purely informative, reducing search costs to consumers by, as Telser (1964) points out informing consumers about locality, price, existence and availability of a good and what characteristics it may have. So, for example, if as a consumer I wanted to obtain free range eggs because I perceived them to be an ethical good, advertising can tell them me where to obtain them from.

The literature on information and advertising often refers to a good's quality as if this can be defined as separate to it's other characteristics. However, while a perception of quality may be communicated via branding, giving an expectation of what the good is like, branding can not reveal everything, nor mean the same thing to two people.

Hence, quality is another subjective area and there has been much discussion in this area. As with ethics, many authors [for example Smallwood and Conlisk, (1979); Davis et al (1991); Davis

(1990)] discuss quality but fail to define the term. Those who do try, do not reach a consensus. However, Oxenfelt (1950) states "Product quality consists of all attributes of a product which yield consumer satisfaction" (p300), an idea echoed by Klein and Leffler (1981) who argue quality is made up of all desirable characteristics. For our purposes we will assume quality includes ethical perceptions.

The common notion that a high price indicates high quality was been researched by Oxenfelt (1950), Leavitt (1954) and Tull, Boring and Consior (1964). All three had supportive findings, but the research is not generalisable due to the limited range of products use (groceries and some carpets) and the samples made up of acquaintances of the researchers, homemakers and military personnel.

Competition is believed to necessitate truthfulness in advertisements, forwarded by authors (for example Ford et al, 1986, Davis et al, 1991; Nelson, 1974) who believe that the market will punish dishonesty through, for example, lack of repeat buying and loss of credibility. Consumers are not seen as ignorant and are believed to be sceptical of unverifiable information relating to search goods, although they are less so when it comes to experience or credence goods. (Ford et al, 1986). Hence, if a good is proposed as ethical and this can be verified prior to purchase, extravagant comments are not expected to occur because consumers will not believe them. However, if ethical content cannot be verified or is only verifiable in the future, consumers may believe them to some extent.

THE ANTICOMPETITIVE VIEW

Another set of authors argue that advertising creates barriers to entry by affecting demand, costs, price and market share. Barriers to entry are considered to exist when existing companies have an advantage over new or potential entrants, and possibly small firms in the market.

COSTS

Costs are said to be a barrier if a new entrant needs to advertise heavily in order to compete with the established companies [see for example Albion and Farris (1981), Comanor and Wilson (1974)]. Obtaining finance at reasonable rates on

interest may be a problem for unestablished companies especially since their success can not be guaranteed in the market place. In addition, Bain (1965) believes that production costs for new entrants are expected to be higher by virtue of the fact they have not been producing as long as an established firm, who, it is argued, may have acquired more efficient production techniques over time.

From the view of ethical production, this view may hold from a different perspective. That is, if a new entrant produces at a higher ethical standard than established firms the literature assumes that higher costs will ensue (Drucker, 1987; Jayne, 1992).

DEMAND

Brand specific advertisements are considered to create barriers because unlike generic advertisements, they focus attention on a specific item and therefore increase product differentiation and reduce substitutability between products (Bain, 1965; Kaldor, 1950). If ethics are important in a consumer's utility function, it is unlikely that they will perceive unethical goods as a close substitute to their preferred ethical good, although advertising is likely to bring about the awareness of a product as having no close substitutes.

PRICES

Decreasing substitutability makes branded products more price inelastic (Kessides, 1986), and may make cross price elasticity fall closer to zero (making goods more independent). This idea would seem to be applicable to ethical goods, as mentioned above.

MARKET SHARE

Ward et al (1985) argue that as product differentiation increases market share for the brand will rise, increasing economies of scale, lowering per unit costs and placing new entrants at a disadvantage. (Bain, 1965).

Hence, advertising may be a barrier to entry or informative, with both aspects able to provide false or true information. This fits into the previous model in figure two, and with simplifying assumptions, it is possible to develop a decision tree of producer behaviour with regards to advertising.

[F] SYNTHESIS

The preceding sections may be synthesised into a decision tree showing producers advertising choices. For simplicity the following assumptions will be made:

(1) There are two firms in the marketplace, one of which is honest, producing an ethical good and always providing true information. Firm Two produces a good perceived as unethical by Firm One, may provide true or false information and competes with the ethical producer.

(2) Quality and ethics will be assumed to be synonymous. Quality is defined as a bundle of desirable characteristics, including ethical content, as perceived by the consumer (Klein and Leffler, 1981).

(3) Market structures are assumed to be monopolistically competitive, or non-collusive oligopolies. Because pure competition assumes perfect information (Baumol et al, 1988) and pure monopoly may impart as much or as little information as it chooses, neither of these two cases will be examined.

(4) Both firms are established, with similar resources available, so it is not feasible for either firm to advertise to the extent they raise barriers to entry.

(5) It is assumed initially that advertisements provide information, as per the decision tree (see figure three).

It is important to reiterate that ethical perceptions and their importance will vary over time. Therefore, something that is now considered unethical by some people, including myself, (for example the fur industry, animal testing, battery hens) may not have been considered unethical a few years ago, either because of lack of awareness or because of changing levels of social acceptability for various views, such as animal rights.

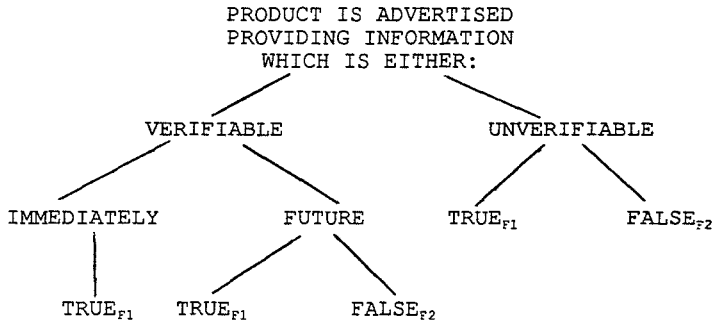
This change in standards through time makes any analysis of ethical goods (even subjectively defined) difficult to accomplish since it is hard to find precise dates of change. However, some guide to changes may be possible with indicators such as the introduction of legislation requiring animal ethics committees.

The study is conditional on what advertising data is available, but the following hypotheses may be drawn from the discussion here.

[G] IMPLICATIONS

(See figure three).

FIGURE THREE
PRODUCERS' ADVERTISING CHOICES
FOR TWO FIRMS



KEY: F_1 = Firm One; F_2 = Firm Two

Hypothesis One:
That if a good is perceived as ethical, and consumers may verify information given about this prior to purchase, telling false information is damaging to the firm and will not result in sales, so only true information is given. This follows the notion of a search good (as defined by Davis et al, 1991) and it should be found that advertising expenditures are low for these goods.

Hypothesis Two:
If a good's ethical content may only be verified in the future, Firm Two has leeway to provide false information. These goods equate to short- and long-term experience goods and it is expected that the advertising expenditures will be large. In this situation, it is expected Firm One's advertising expenditure will be large to counteract false information or they may use litigation to reduce false information entering the marketplace. (This hypothesis is based on Klein and Leffler (1981) who believe that a firm may charge a premium price in a market place to prevent falsehoods in information. Charging a high price creates supernormal profits but this is spent on advertising to prevent others entering the market - for example, Coca-cola and Pepsi).

Hypothesis Three:
If the ethical content can only be verified in the future and turnover from the product is small, Firm one may choose not to advertise at all, because the marginal benefit from advertising is expected to be low.

Hypothesis Four:
If a good's ethical content is non-verifiable over time, Firm two may lie. These goods are credence goods, and it is expected that advertising will be minimal for these items, since if the ethical content can not be verified, the product's existence is the only information worth communicating to the consumer.

[H] SUMMARY

The failure of the business ethics literature to adequately reconcile ethics into the economic model necessitates further study in this area. Examining ethics from the producer's viewpoint with regards to the ethical content of the goods they supply to consumers, brings us into the arena of information markets. It is expected that advertising levels and the information on a good's ethical characteristics will vary with the type of good supplied and the verifiability of information provided. The levels of advertising and the type of information conveyed is expected to have changed over time, just as ethical standards and ethical perceptions have changed. If insufficient data exists, a case study in an industry (such as the fur or egg industry) which uses animals will be used to investigate these ideas.

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A Preliminary Analysis of the United Kingdom Sheepmeat Sector

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Abstract

The period 1982 to 1992 has been very dynamic for the United Kingdom sheepmeat sector. The purpose of this paper is to model two of the major changes that have occurred in this period. The first change concerns imports. In 1989 the voluntary export restraint imposed on the main exporter to the United Kingdom, New Zealand, was reduced by 40500 tonnes and the ten per cent tariff on those imports removed. The second change involves producer subsidies in the United Kingdom. In January 1992 the variable premium producer price support was removed. It is expected that the removal of the supply subsidy will result in higher market prices both to the consumer and the producer. Supply and demand equations have been specified to examine the effects of the above industry changes. Various supply and demand side scenarios have been postulated and statistical results from the resulting calculations are presented.

A Preliminary Analysis of the United Kingdom Sheepmeat Sector

The period 1982 to 1992 has been very dynamic for the United Kingdom sheepmeat sector. The purpose of this paper is to model two of the major changes that have occurred in this period, the removal in 1989 of the 10 per cent tariff on New Zealand imports and the accompanying decrease in the quantity of the voluntary export restraint and the removal of the variable premium producer subsidy in January 1992.

Background

The EEC sheepmeat regime began on 20 October 1980. Members of the EC could choose one of two methods of support for their producers, intervention buying or variable premium payments. This allowed member states to choose the system most suited to its own policy environment. The United Kingdom was the only member state to choose the variable premium alternative. This could most easily replace the Fatstock Guarantee scheme already in situ. Payment of the variable premium had a dual purpose, to increase self sufficiency in sheepmeat production and to spread supply through the year. A shortage of lamb persisted however in the period April to June each year.

The scheme operated as follows; an average market price (AMP) was calculated using market prices for lambs and other sheep under one year. A guide price based on seasonal basic prices set by the EC Commission, and fixed in terms of European Currency Units (ECUs) to allow for devaluation or revaluation of the United Kingdom green currency, was quoted for the week. Producers would receive a subsidy of 85 per cent of the difference between the AMP and the guide price. Sheep over one year defined as those with two or more permanent incisor teeth would receive variable premium payments but the price for this category was not included in the calculation of the AMP. The variable premium was paid on all sheep and lambs sold in that week (provided the stock met certification standards set by the Meat and Livestock Commission). There was no maximum payment as in the case of cattle and the payments were wholly funded by the European Agricultural Guarantee and Guidance Fund (EAGGF). The variable premium was also equal to the clawback, the charge made on exports of sheepmeat and live sheep to the other member states.

During the 1980s EAGGF total expenditure increased by 360 per cent. The sheepmeat regime took 5 per cent of total expenditure in 1990, more than double the proportion in 1980. The UK share of total expenditure was 98 per cent in 1981 but this fell to 27 per cent by 1988. This is a 47 per cent increase compared with the 360 per cent total increase. The increase in the costs of agricultural support has not been proportionate to the increase in production indicating inefficiency in the levels of production induced by the subsidies. Aligning support prices will give greater scope for equitable budgetary cutback. A further incentive to aligning support practices has been the move to a single market by 1992. The presence of a clawback on exports of UK lamb to other member states provides a barrier to free trade and the need for frontier controls at odds with the concept of the free market.

In January 1990 the variable premium was reduced to 75 per cent of the difference between the guide price and the AMP and an aid to private storage scheme (APS) introduced to begin the transition from the variable premium scheme to the APS used by all other members of the EC. In January 1991 the percentage of the difference between the AMP and guide price was again reduced to 55 per cent and on January 5 1992 the variable premium payment ceased to exist as did the corresponding clawback charge. The EC sheep support system operates from that date on a standard all country basis using headage payments on qualified breeding ewes. As a result, large adjustments in the national average price of prime lambs are expected to emerge in the Irish Republic, France, Northern Ireland and the UK, although the EC average under the new support system is expected to be similar to that under the previous arrangement. This is because the UK average is expected to rise following the removal of clawback repayments on UK exports and the French and Irish averages are expected to fall (AgraEurope, 1992, No.1472).

To further align support given to the UK with that given to the other EC states the ewe premium was increased as the variable premium decreased (this is the headage payment mentioned previously). This is an annual payment, again decided by the EC Commission, split into either two or three instalments and made to sheep producers based on the number of ewes in their flock. These payments vary within countries based on geographical and land considerations, for example producers in Northern Ireland receive a higher payment per ewe than producers in England and within England hill country producers are designated as less favoured areas than those on lowland. From 1980 to 1989 the UK flock expanded from 14 million to just over 20 million ewes and ewe lambs. This expansion allowed the increase in exports to France and the decrease in imports, the vast majority of which come from New Zealand. A stabiliser to the ewe premium was introduced in the EC in February 1988 proposing a goal of a total of 62 million ewes in the EC eligible for some form of the ewe premium. Its purpose was budgetary control. If the UK continued from this time to operate the variable premium scheme a separate limit of 18 million ewes would apply. A one per cent reduction in the guide price for each percentage point by which the total ewe flock exceeded the pre-determined maximum guaranteed level would result. This could represent a significant decrease in income from the EAGGF to the UK.

The demand for sheepmeat in the UK has remained static at approximately 15.47lb (7.02kg) per annum between 1982 and 1992. Despite the various forms of support supply does not meet demand.

New Zealand exports to the UK declined in absolute quantity over the period 1982 to 1992, from 214,340.8 metric tonnes (mt) to 105,368.5 mt. They have also declined as a proportion of total New Zealand sheepmeat exports to the EC, from 88% to 51%. In this period New Zealand exports were subject to a 10% ad valorem levy and a quota limit of 245,500 mt from 1982 to 1988 inclusive. In 1989 the levy was dropped and the quota decreased to 205,000 mt. This quota is current. The reduction in the levy constituted a gain to the New Zealand industry of $60 million. In the quota there is a specified amount allowed of chilled lamb. This has increased from 6000 mt in 1989 to 10,500 mt in 1992 (AgraEurope, 1992, No.1472). The price received by New Zealand producers has, over the 1982 to 1991 period, been considered to be the main factor in the consistent shortfall between the quota and the quantity of New Zealand sheepmeat supplied to the UK market (Department of Agricultural Marketing, University of Newcastle, 1985).

The effect of the 1992 arrangement will result in a greater distribution of British lamb throughout the EC market (AgraEurope, 1992, No.1472). The rise in the UK price is likely to be tempered by the increase in exports from New Zealand although the New Zealand Meat Producers Board is "expected to concentrate on price instead of volume" (AgraEurope, 1992, No.1478) in keeping with greater pre-export processing and increased volumes of chilled rather than frozen lamb.

Model Formulation

Supply and demand functions were estimated using ordinary least squares. As the model could be specified as a system with a mutual price of lamb variable a two stage least squares model was trialed proposing either the producers price in both markets or the retail price of lamb. However this model failed to produce results with the signs of the variables in accord with theory. As the two markets are considerably divorced by the support structures the markets were modeled independently. One of the policy objectives of the sheepmeat regime in the United Kingdom has been to maintain low retail prices for the consumer. This is achieved by the support subsidy therefore the price the producers respond to and the price the consumer pays are poorly linked.

The theory of demand postulates that demand for a product is based on its price, on the price of substitutes and complements and on income. The price of lamb, price of beef, price of pork, income and dummy variables for seasonality were used in the demand for lamb at the retail level.

The theory of supply postulates that supply of a product is based on the price the producer receives for the product, the price of inputs and the price of competing products. Supply was modeled using the producers price of lamb (market plus variable premium), the producers price of beef, and dummy variables for the change in the voluntary export restraint, the removal of the variable premium and seasonality. The real wage rate was used as an indication of changing input costs but this variable was highly collinear with the producers price of beef and neither the sign nor the magnitude would remain stable as alternate regressions were run. Therefore the variable was dropped. The producers price of beef was used as the main competing enterprise price variable. This was adjusted for the average level of support which is subject to several constraints and more closely approximates the market price than that of sheepmeat.

A dummy variable was used to model the shift in supply due to the change in the voluntary export restraint and the removal of the variable premium. Dummy variables were also used to capture the effects of seasonality.

Results of the Ordinary Least Squares Regression

QS = 56677 + 230.19 RPLUS - 376.05 RPRPRB + 19255 VER
(4.178) (2.121) (-1.841) (-1.813)

- 5976.68 JAN92 - 21186 QT1 + 10569 QT3 - 25464 QT2
(5.274) (-5.973) (4.430) (-7.203)

Adj. R^2 = 0.86 DW = 1.671 F = 38.53

QD = -12187 - 568.41 RPL + 1008.30 RPB + 426.26 RPP
(-0.291)(-2.401) (3.299) (1.243)

+ 0.000000561 RYD - 847.01 QT1 + 11691 QT3 + 3882.37 QT2
(1.817) (-0.289) (4.623) (0.872)

Adj. R^2 = 0.60 DW = 1.503 F = 10.11

Table 1: Quarterly Sheepmeat Model Variable Definitions

Variable	Definition	Units
MP[1]	UK IMPORTS	tonnes
QD[1]	QUANTITY DEMANDED	tonnes
QS[1]	QUANTITY SUPPLIED BY UK PRODUCERS	tonnes
RPB[1]	RETAIL PRICE BEEF UK (deflated by retail price index)	
RPL[1]	RETAIL PRICE LAMB UK (deflated by retail price index)	
RPP[1]	RETAIL PRICE PORK UK (deflated by retail price index)	
RPRPRB[2]	PRODUCERS PRICE BEEF (deflated by CPI (UK))	p/kg
RYD[1]	REAL INCOME (deflated by CPI UK)	million £
QT1	FIRST QUARTER DV	
QT3	THIRD QUARTER DV	
QT2	SECOND QUARTER DV	
JAN92	REMOVAL VARIABLE PREMIUM SCHEME	
VER	CHANGE IN TARIFF AND NON TARIFF BARRIERS	
RPLUS[2]	MARKET PRICE FOR LAMB PLUS VARIABLE PREMIUM	p/kg

[1] Source Meat and Livestock Commission (UK) Meat Demand Trends
[2] Source Meat and Livestock Commission (UK) Weekly Market Survey

Discussion

The voluntary export restraint (VER) and the removal of the variable premium (RVP) variables represented significant shifts in the supply curve, a 19255 tonne increase and 5976.68 tonne decrease respectively. While it is difficult to say with absolute certainty that the dummy variables are picking up only the effect of interest both were significant at the ten percent level and had the a priori expected signs.

All three seasonal variables were significant in the supply equation and had the a priori expected signs. Over the first and second quarter supply shifted downwards relative to the fourth quarter while the third quarter shifted upwards. There is a supply shortfall in the April to June period each year. The respective changes were a 21186 tonne decrease in the first quarter, a 25464 tonne decrease in the second quarter and a 10569 increase in the third quarter.

Only the third quarter shift in demand was significant and possibly indicates a change in food habits or some response to seasonal supply. The removal of the variable premium should have some effect on the magnitude of the seasonal fluctuations as it was also designed to decrease the same.

Elasticities for the variables in each equation were estimated using the eleven year average, the average of the most recent two years and the most recent year and also the last observation point elasticity (see table 2).

Quantity demanded with respect to real income is inelastic for all four periods estimated, both in the short run and the long run. Quantity demanded is also inelastic with respect to own price and the price of substitutes in the short and long run. This is frequently the case with food items, particularly those seen as necessary items.

Quantity supplied with respect to own price and the price of the competing enterprise is again inelastic in both the short and long run. This is unusual as it could be expected that in the long run resources are less immobile and supply would be more elastic with respect to its own price. Based on the elasticity calculated however this would explain the proportionately less increase in quantity supplied while the costs of the variable premium scheme continued to increase.

Table 2. Elasticities

Elasticity	11 Year	2 Year	1 Year	Last Obs.
Qd wrt RYD	0.2720	0.3473	0.3618	0.3501
QD wrt RPL	-0.5010	-0.3944	-0.4049	-0.3582
QD wrt RPB	0.9245	0.7830	0.7806	0.7371
QD wrt RPP	0.3896	0.3429	0.3477	0.3227
QS wrt RPLUS	0.8166	0.6786	0.7291	0.5991
QS wrt RPRPRB	-0.6126	-0.5728	-0.6231	-0.5433

Notes
1. Abbreviations as for those in table 1
2. wrt with respect to.

After running the regression several scenarios for changes in retail price and supply price were run. On the demand side the first scenario run assumed that nominal retail prices would continue to rise at the same rate as the previous two years, 0.61 per cent. The second scenario assumed that prices would rise at the same rate as that of imported lamb over 1991 to 1992, 1.7 per cent. A third scenario was run at a 5 per cent increase. On the

supply side a base scenario was run that assumed that after the initial rise prices would remain static. A second scenario was run allowing prices to increase at the same rate as the combined variable has in the 1990 to 1992 period, the average rate for each year was calculated and all were around -2.2 per cent so that average of the three was taken and the variable decreased at 2.2 per cent. As it is predicted that market prices will rise, they will have to rise at 26.57 per cent to maintain the price to producers (falling at 2.2 per cent) that they have received as a combined variable premium and market price over the previous three years, 1990 to 1992. The quantity changes under the various scenarios are reported in table 3.

Table 3. Quantity Changes Under Various Price Scenarios.

Demand				
Baseline Scenario 0.061%	Scenario 1 1.7%	Change from BL[1] (tonnes)	Scenario 2 5%	Change from BL (tonnes)
91466.8	91004.1	462.7	89596.73	1870.07
98526.64	98083.56	443.08	96744.81	1781.83
107895.7	107515.5	380.19	106484	1411.69
94828.25	94444.39	383.86	93286.69	1541.56
98423.51	98018.36	405.15	96790.84	1632.67
100012.6	99577.68	434.95	98257.94	1754.69
109048.2	108669.9	378.35	107520.2	1528.08
97391.92	97024.93	366.99	95912.38	1479.54

Supply		
Scenario 1 2.2%	Baseline Scenario 0.0%	Change from BL[1] (tonnes)
53672.1	54294.14	-622.04
49629.12	50276.99	-647.87
81872.36	82400.05	-527.69
71650.15	72174.23	-524.08
53544.49	54911.85	-1367.36
49395.29	50792.29	-1397
81435.13	82574.95	-1139.82
71247.92	72381.75	-1133.83

[1] BL is baseline scenario

The domestic average market price of sheepmeat has risen in 1992 with the removal of the variable premium producer payment. This price is likely to be translated into higher domestic retail prices and a fall in demand accordingly. Demand is inelastic with regard to price and a 5% decrease in price results in an average 406.91 tonne decrease in consumption. Retail prices will rise with the removal of the variable premium. If some translatability is assumed, at a 20 per cent increase in retail price, quantity demanded over the two year period falls by an average of 6768 tonnes per quarter. This compares with the baseline change in supply at the average market price increase of 26.57% of 920 tonnes (decrease). However the model is unable to simulate the change in price in both markets simultaneously and the equilibrium changes are not estimated here. The inefficiency noted previously in the disparity between the costs of the variable premium scheme and the resulting production may indicate that producers may become more efficient and livestock market prices may in fact fall.

As noted previously an increase in price is likely to result in an increase in exports to the UK. However in New Zealand's case a voluntary restraint agreement has been made and the limit met in the 1990 to 1992 period. An increase in returns will result from the price change but not from an increase in quantity.

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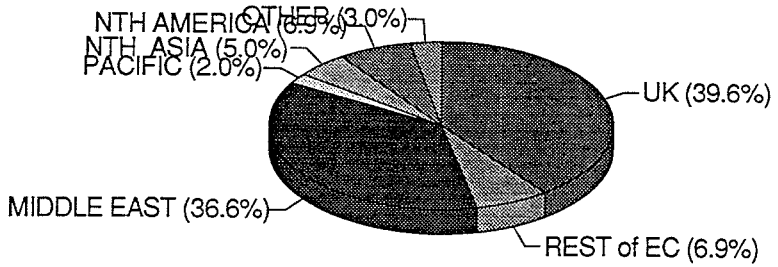
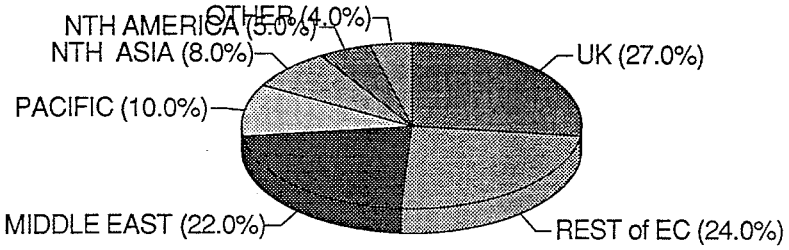
DESTINATION FOR NZ LAMB EXPORTS

1980-81



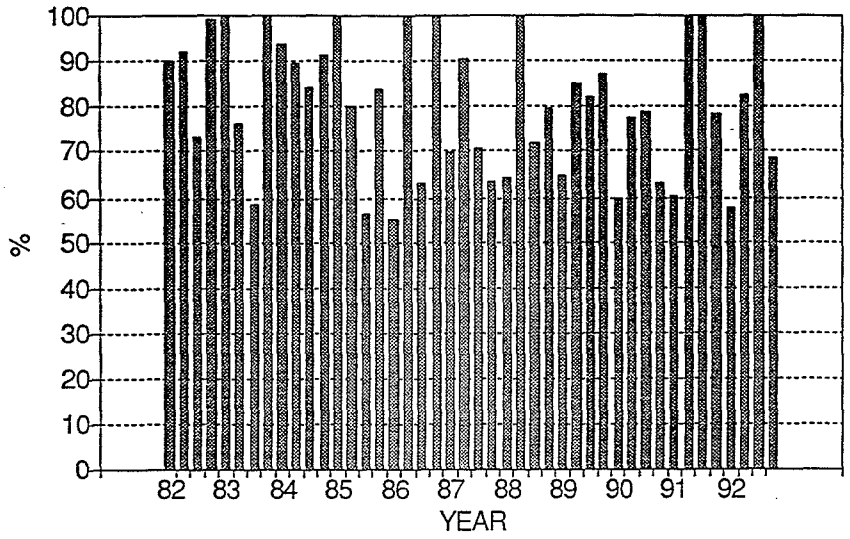
1990-91



Source: New Zealand Meat Producers Board

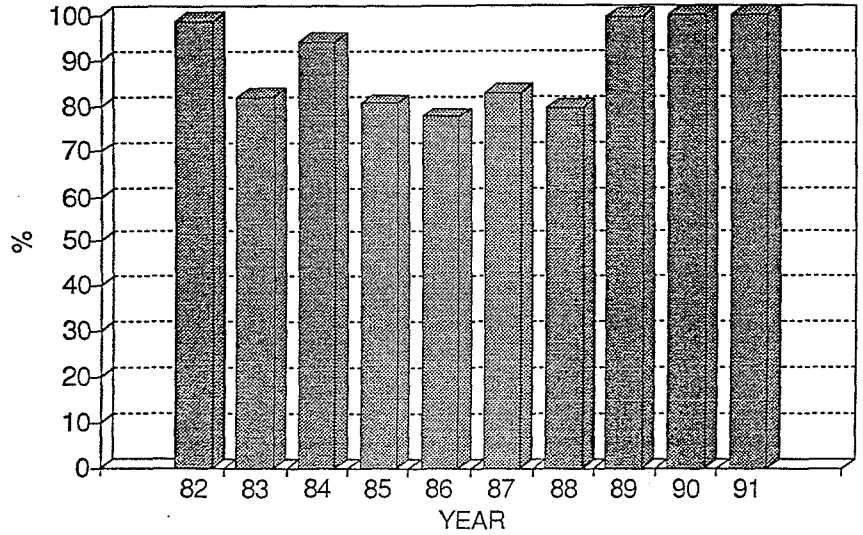
NZ EXPORTS AS % UK IMPORTS

1982 TO 1992



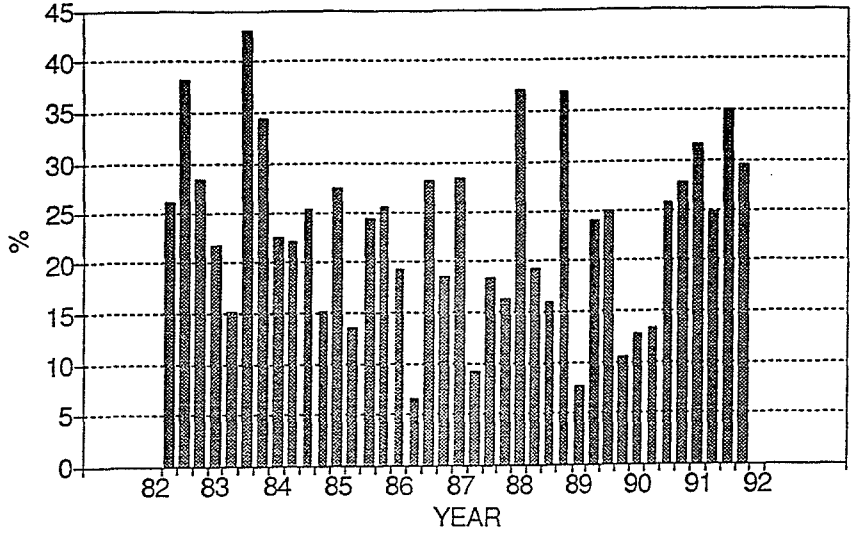
PERCENT OF VER FILLED

1982 TO 1992



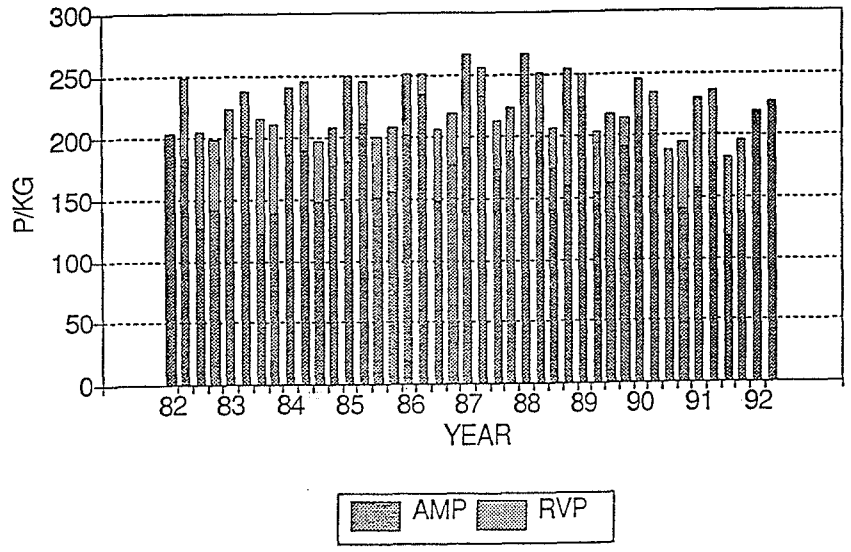
VAR.PREM. AS % OF TOTAL RETURNS

1982 TO 1992



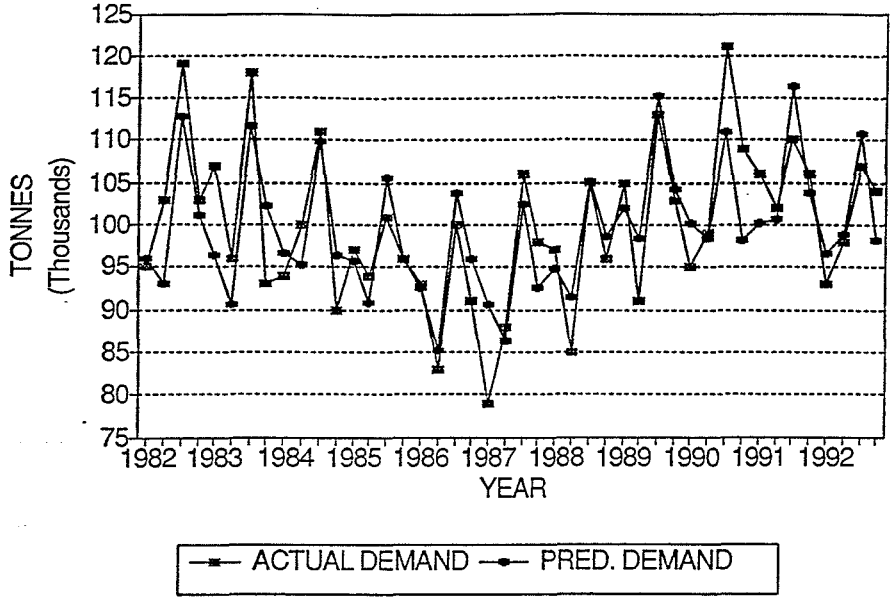
PRODUCER RETURNS

1982 TO 1992



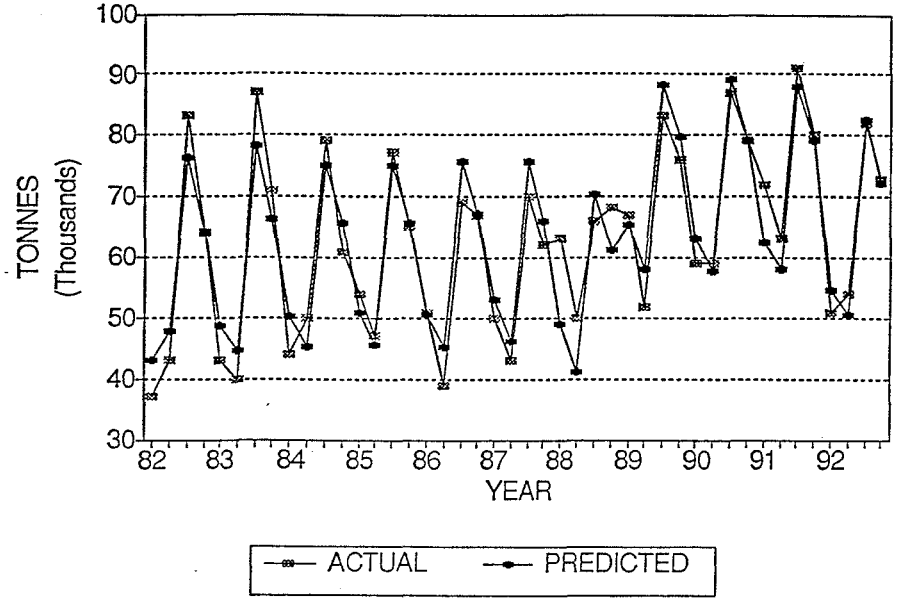
QUANTITY DEMANDED UK MARKET

1982 TO 1992



UK DOMESTIC SUPPLY

1982 TO 1992



Comparison of relative economic values for lamb carcass traits in different seasons of the year and regions of New Zealand

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ABSTRACT

Market returns from NZ export lamb from 1987 through 1990 were analyzed in order to quantify the incentives to produce lean heavy carcasses. The incentives were quantified in $/kg carcass weight relative to $/mm fat depth. Stochastic simulation was used to generate a population of carcasses with a normal distribution for carcass weight and a lognormal distribution for fat depth. Individual lambs of the simulated population were drafted to be slaughtered according to assessed fat depth and valued according to weighted average price schedules for different regions of New Zealand and seasons within years. Comparison of returns at a constant feed cost showed that the relative economic value of increasing carcass weight by 1 kg was 2.82 times the value of decreasing GR by 1 mm. The estimate of this ratio for the North Island was .42 greater than for the South Island.

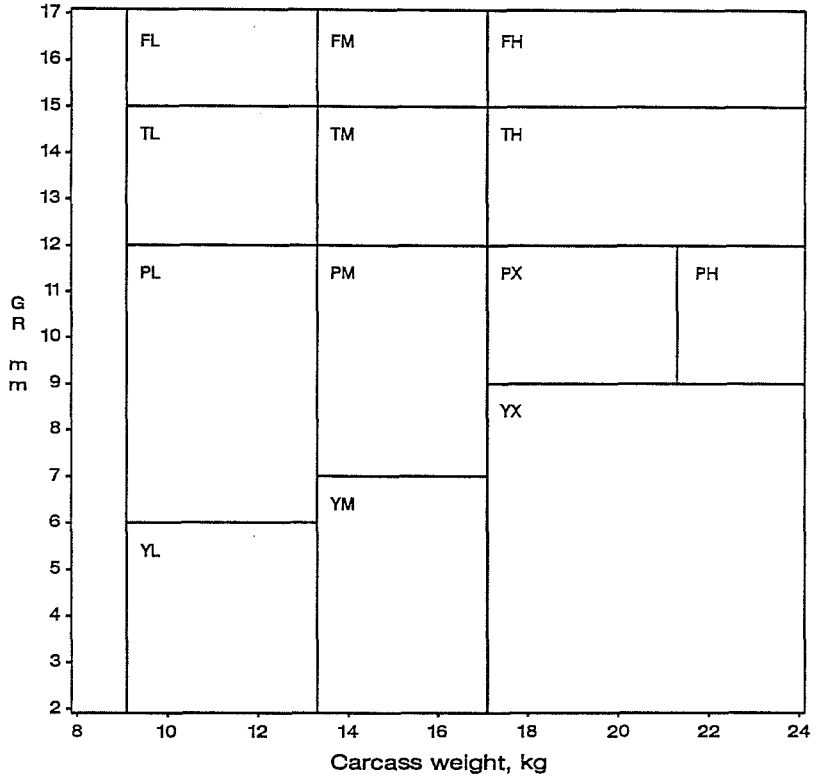
INTRODUCTION

The export lamb producer's returns are determined by the schedule which sets prices for carcasses of different classes. The NZ export lamb classification system uses carcass weight (HCW) and GR, a measure of fat depth, as criteria to separate carcasses into categories of defined weight ranges and fat classes (Figure 1). Meat companies set prices for carcasses within these categories.

Price differences between carcass classes can be thought of as rewarding the production of lean meat and penalizing fat or alternatively, rewarding HCW and penalizing GR. These rewards and penalties are implicitly encouraging a balance between selection for increased lean tissue and against increased fat tissue in lamb carcasses. This balance can be expressed in relative economic values (REVs) for carcass traits for use in a selection index designed to maximize economic response

through a balanced emphasis on each component of the breeding objective (Clarke et al. 1991).

Figure 1. Export Lamb Carcass Classes



The REV of a trait is an expression used in animal breeding that refers to the marginal profit of one additional unit of the trait. Partial regression coefficients were used to estimate the balance of rewards and penalties, derived from annual national schedule summaries for export lambs by Simm et al. (1987) and Waldron et al. (1991). In the latter report it was suggested that there may be important differences in the REVs among regions within the country and/or among different seasons within a marketing year.

The objectives of this study were to 1) compare the REVs of carcass traits among different seasons of the year and different regions of New Zealand, and 2) to determine if a small number of price differences or ratios across carcass classification boundaries could be used to explain variation in REVs, and to indicate changes in market signals being provided to lamb producers and ram breeders.

MATERIALS AND METHODS

Market data

Summaries of regional and seasonal lamb schedules were obtained from the NZ Meat & Wool Boards' Economic Service. The summaries provided the number of carcasses, average HCW and net returns by carcass class for each of five regions for each two month period in each marketing year from 1987/88 to 1989/90. A marketing year began on 1 October. The five regions were 1) Auckland, 2) Hawkes Bay, 3) Taranaki, Wanganui, Wellington, 4) Canterbury, Westland and 5) Otago, Southland. Net returns were exclusive of per head charges and premiums.

Simulation

A stochastic simulation was used to generate populations of carcasses for estimation of REVs of HCW and GR. The distributions were chosen to represent a typical New Zealand flock which markets lambs between 4 and 7 months of age. The simulation methods and drafting strategy were an adaptation of that used by Garrick et al. (1986).

Initial Distributions

The simulation began with correlated distributions of HCW and GR at weaning on 1 November. The simulated HCW and GR values for an individual lamb were generated by transforming a vector of 2 pseudo-random normal deviates obtained from the rannor function of SAS (1987). The 2 x 1 vector was multiplied by the Cholesky decomposition of the covariance matrix which had variances of 1.44 kg^2 for HCW, 3.24 mm^2 for GR and a correlation between them of .8 (Waldron et al. 1992). A constant of 8 kg was added to the first element of the vector which was used as the value of simulated HCW.

A pseudo-random uniform (0,1) deviate from the ranuni function of SAS (1987) was generated for each individual to assign sex (ram or ewe). A constant .5 kg was added to the HCW of rams.

Analysis of experimental data has revealed that the distribution of GR is skewed to the right. Therefore the second element of the 2 x 1 vector generated for each individual was transformed to a lognormal distribution with a mean of 2 mm for GR. Resulting means, standard deviations and correlation are shown in Table 1. The resulting correlation was lower than .8 because of the addition of .5 kg to the HCW of rams.

Table 1. Starting distribution for simulation of lamb carcass traits.

Trait	Mean	sd
HCW, kg	8.25	1.21
GR, mm	2.00	1.78
correlation	.68	

Simulated Growth

Growth in HCW and GR was simulated in 28 day periods. The simulated increases in HCW and GR for each 28 day period were generated for each individual lamb from a pair of pseudo-random normal deviates transformed so that the means and standard deviations of HCW and GR growth were as shown in Table 2 and the correlation between them was .75. The decline in growth rates from November to March for 4 to 7 month old lambs is typical of New Zealand conditions (Geenty & Clarke, 1977). The growth rates correspond to liveweight gains of 181 to 89 g/day for rams and 165 to 85 g/day for ewes.

Table 2. Mean HCW and GR growth for each 28 day feeding period.

	HCW, kg		GR, mm	
Period	ewes	rams	ewes	rams
1	2.1	2.3	1.8	1.7
2	2.1	2.3	2.0	1.9
3	1.7	1.9	1.7	1.7
4	1.3	1.4	1.4	1.3
5	1.1	1.1	1.2	1.2
sd	.50	.60	.60	.55

Average, Lean and Heavy flocks

Three flocks were simulated, each flock had 2000 lambs. The values in Table 1 are of the Average flock. The second flock (Lean) was generated by subtracting a constant 1 mm from the simulated GR from each individual of the Average flock. The third flock (Heavy) was generated by adding a constant 1 kg to the simulated HCW of each individual of the Average flock. Throughout all growth periods the same random numbers were used once for each of the 3 flocks. The values generated for the first lamb of the Average flock were also used for the first lamb of the Lean flock and the first lamb of the Heavy flock. Thus the differences between flocks had no random component.

Drafting strategy

At the end of the 2nd 28 day feeding period (27 December) lambs were drafted based on assessed GR. In order to simulate the effect of imperfect assessment of GR, lambs were drafted to be marketed if the value of simulated GR plus a pseudo-random normal deviate with mean zero and standard deviation 3 mm (Kirton et al., 1991a) was greater than 9 mm. As with the random numbers for growth, the random numbers used for the GR assessment of the first lamb of the Average flock were also used for the first lamb of the Lean flock and the first lamb of the Heavy flock. This conservative drafting strategy was employed to avoid financial penalties for lambs with greater than 12 mm GR (T and F, Figure 1). Drafting on the basis of GR was shown to have an advantage over drafting by weight by Garrick et al. (1986). Lambs that were not drafted were grown for another 28 day period. The GR assessment and drafting were carried out again at the end of the 3rd and 4th 28 day periods, on 24 January and 21 February, respectively. A new series of pseudo-random numbers was generated in each period for GR assessment.

Final drafts - Feed supply

All lambs of the Average flock remaining on feed after the 4th period were marketed after a further 28 day feeding period (21 March). This corresponds to a date when the lamb feed supply for a typical farm has been judged to have been depleted. In order to

make comparisons of returns at a constant feed cost, the Lean and Heavy flocks' feed supplies were set equal to the total feed consumed by the Average flock. Feed consumption was measured in MJ of metabolizable energy (ME). The equations presented by Townsley (1986) were used to calculate ME requirements of each lamb as a function of weight and growth rate. It was assumed that the quality of feed was constant throughout the feeding period and that there were no feed efficiency differences between flocks. All lambs remaining on feed after the 4th period were marketed when their respective flock had depleted its feed supply.

Carcass valuation

Individual carcasses were given a meat value according to the price/kg of HCW from each regional and seasonal schedule summary. Therefore, each carcass was given 90 different meat values (3 years x 6 seasons within a year x 5 regions). All carcasses were priced on the same schedule regardless of the day on which they were marketed. The increased returns/lamb of the Heavy and Lean flocks over that of the Average flock were the estimated REVs of HCW and GR, respectively.

Analysis of REVs

The relative economic values for each of the 90 year-season-region weighted average schedules were then expressed as ratios (HCW:GR) and analyzed with Model 1 using SAS GLM (1985).

[1] $$ratio_{ijk} = year_i + season_j + region_k + error_{ijk}$$

This analysis was carried out for 1) all 90 year-season-region ratios and 2) 45 ratios from the 3 seasons of the year (December-May) which account for 75% of New Zealand export lambs. Hypotheses tests were applied to test for significant differences among years, regions and seasons.

Schedule Statistics

An observation of plots of $/kg of HCW (Figure 2) by class suggested that there were groups of classes that were usually priced similarly. The classes with the highest $/kg were PH, PX, PM, YX, and YM. The second group was made up of YL and PL. These two groups of classes accounted for 93% of the carcasses from 1985/86 to 1989/90. The alpha class was usually priced lower than the YL and PL classes. There was little difference between T and F classes within a weight range, but the T and F classes had prices substantially lower than all others. Accordingly, the following price differences and ratios across classification boundaries were calculated as statistics of potential value as indicators of carcass trait REVs implicit in a schedule.

Light-Medium	LMD = [(PYM+PPM)/2] - [(PYL+PPL)/2]
	LMR = [(PYM+PPM)/2] / [(PYL+PPL)/2]
Medium-Heavy	MHD = [(PYX+PPX+PPH)/3] - [(PYM+PPM)/2]
	MHR = [(PYX+PPX+PPH)/3] / [(PYM+PPM)/2]
Prime-Trimmer	PTD = [(PPM+PPX+PPH)/3] - [(PTM+PTH)/2]
	PTR = [(PPM+PPX+PPH)/3] / [(PTM+PTH)/2]

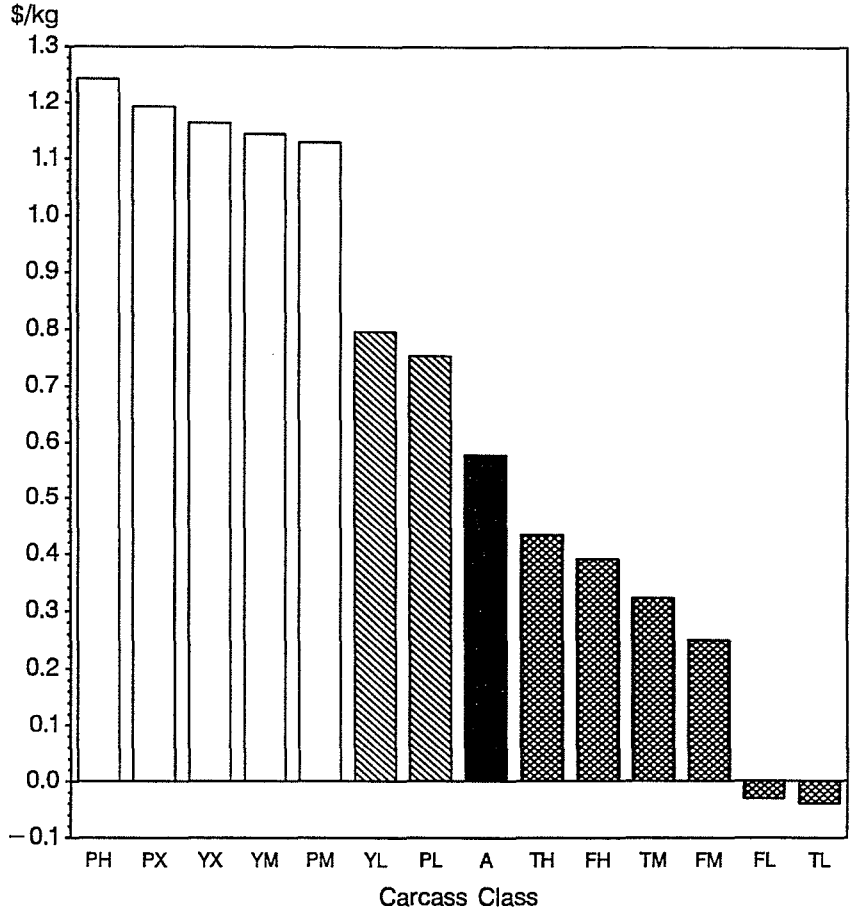
where, PPM is the price in $/kg HCW of carcasses in the PM class and similarly for the other classes.

Thus, LMD was the premium paid for carcasses in the M weight range over the L weight range. The ratio of these prices was LMR. A high LMD or LMR would encourage carcasses above 13.3 kg HCW, a high MHD or MHR would encourage carcasses above 17.1 kg HCW, and a high PTD or PTR would encourage carcasses below 12 mm GR. The LM boundary is potentially important because it involves the four classes which contained 83% of the carcasses from 1985/86 to 1989/90. Because of the high number of carcasses that would be affected, a small difference in $/kg can have a large effect on returns. Similarly a small difference in HCW can have a large effect on returns if it changes the weight range in which the carcass falls. The PT difference is usually

substantial, reflecting a penalty for fat. The classes involved in calculating PT contained 29% of the carcasses from 1985/86 to 1989/90.

Schedule statistics (LMD, LMR, MHD, MHR, PTD, and PTR) were calculated for each of the 90 year-season-regions and correlations with the estimated ratios of economic values (HCW:GR) were computed. The ratios were analyzed by regression with the schedule statistics as independent variables.

Figure 2. Dollars/kg of HCW by class



RESULTS

The final draft of lambs from the Lean and Heavy flocks had depleted their feed supply and were taken off feed 22 and 20 days before the Average flock. The percentage of lambs marketed at each draft are presented in Table 3. After the first draft, a higher proportion of the Lean flock remained on feed. Consequently, the lambs of the Lean flock remaining after the 3rd draft had depleted their feed supply and were marketed 6 days after the 3rd draft (27 February). The greater feed requirements, due to the larger body size, of the lambs of the Heavy flock resulted in their feed supply being depleted 8 days after the end of the 3rd draft (1 March).

Table 3. Percentage of lambs marketed by draft.

	Draft			
Flock	1	2	3	4
Average	15	26	29	30
Heavy	15	26	29	30
Lean	10	20	27	44

The mean return of the Heavy flock was $1.65/lamb greater than the Average flock. The mean return of the Lean flock was $0.59/lamb greater than the Average flock. The mean of the ratio (Heavy:Lean or HCW:GR) was 3.14. The increased returns of the Heavy flock were due to increased HCW at slaughter. The percentage of lambs of the Heavy flock drafted at each period (Table 3) was equal to the Average flock. The increased returns of the Lean flock were primarily due to a more desirable distribution of classes due to lower GR (i.e. more high value YM and YX carcasses and fewer carcasses in the lower value PL class, and fewer in the T and F classes). The mean HCW over all drafts of the Lean flock was only slightly greater (.03 kg) than the Average flock (Table 4). The Lean flock had greater mean HCW in the early drafts because a smaller percentage of lambs were drafted relative to the Average flock. Because of a lower percentage of lambs being drafted, there were more lambs remaining on feed after each of the first 3 drafts and therefore the feed supply was depleted sooner. The mean HCW of the Lean flock was less for the fourth draft because of the much shorter final feeding period.

Table 4. Mean HCW and GR by draft for Average, Heavy and Lean flocks.

Draft	1		2		3		4		All	
Flock	HCW	GR	HCW	GR	HCW	GR	HCW	GR	HCW	GR
Average	13.6	7.6	14.8	8.2	15.7	9.6	16.1	9.8	15.3	9.0
Heavy	14.6	7.6	15.8	8.2	16.7	9.6	16.3	9.0	16.0	8.7
Lean	13.9	7.3	14.9	7.6	15.9	8.9	15.4	8.1	15.3	9.0

In the analysis of the ratios from all seasons of the year with Model 1, year was the only effect that was a significant ($p < .10$) source of variation. Evaluation of the distribution of ratios by season showed that the variance of ratios for each of Seasons 1 (Oct.-Nov.), 5 (June-July) and 6 (Aug.-Sept.) were markedly higher than the other seasons (Dec. to May). When the analysis was repeated using only schedules from Dec. to May, the mean advantages over the Average flock were $1.60 and $0.58/ lamb for the Heavy and Lean flocks, respectively. The mean ratio (Heavy:Lean or HCW:GR) was 2.82. The effects of year and region were significant ($p < .02$) sources of variation when Model 1 was applied to the ratios from Dec. to May. The least squares mean of the 3 North Island regions was .42 greater ($p < .05$) than the 2 South Island regions (Table 5). This difference was due to a larger REV of HCW in the North Island compared to the South Island.

Table 5. Least square means of ratios of economic values.

Year		Island	
87/88	2.89	North	3.01
88/89	2.38	South	2.60
89/90	3.16		

Schedule statistics as predictors of ratios of economic values

Estimated correlation coefficients of schedule statistics with ratios are presented in Table 6 using schedules from all seasons of the year and schedules from December to May only. The schedule statistic that had the largest, in absolute value, estimated correlation with the estimated ratio of economic values (Dec. to May) was MHD ($r = .75$). PTR and MHR also had correlations that were significantly different from zero ($p < .01$).

Table 6. Correlation coefficients of schedule statistics with estimated ratio of economic values.

	Complete year	December-May
LMD	-.01	.33*
LMR	.04	.12
MHD	.17	.75**
MHR	.15	.64**
PTD	-.08	.12
PTR	.04	-.48**

** p<.01; * p<.05; + p<.10

A multiple regression equation which included MHD and PTR as predictors of the ratio yielded an r^2 value of .60 for the schedules from December to May. None of the other schedule statistics were significant sources of variation at the p=.2 level of significance. The residual standard deviations for the ratios from this model were 2.23 for the complete year and .38 for schedules from December to May.

DISCUSSION

Some previous estimates of REV's of carcass traits for New Zealand lamb (Simm et al. 1987; Waldron et al. 1991) used a simulated population with class proportions similar to the national average and multiple linear regression methods to estimate REVs. The simulation used in the present study is more appropriate to a single farm with class proportions that are different from the national average. The starting distributions and growth rates can be altered to be representative of a specific farm. The mean ratio of economic values (HCW:GR) of Waldron et al. (1991) was 2.00 for the simulated national population and 2.75 estimated from carcass data from a research flock. The market information used in the present study is a subset of that used by Waldron et al. (1991). The smaller data set was used in this study because the regional and seasonal data was not available for 1985/86 or 1986/87. The means of the ratios reported by Waldron et al. (1991) of the years that are common to both studies were 1.91 for the national population and 2.62 for the research flock. The higher ratio estimates from the present study were due to the different class proportions. The class proportions were different because of 1) the different distributions used to generate the populations and 2) the

simulated drafting strategy employed in the present study. The proportion of carcasses in the T and F classes in the present study was 5%. The research flock of Waldron et al. (1991) also had 5% T and F class carcasses and their simulated national population had 12% in the T and F classes. The effect that the drafting strategy had was an avoidance of financial penalties for overfat carcasses by slaughtering the fatter lambs before GR grew above 12 mm while growing lambs to heavier weights.

Garrick and Purchas (1989) reported increased returns of $.93 in ewe lambs and zero in ram lambs for reducing GR by 1 mm. The mean of both sexes is slightly lower than the estimate of the present study ($.60). In the present study the REV of increased HCW was calculated assuming no change in GR and is therefore not directly comparable to the REV estimate of Garrick and Purchas (1989) which was calculated assuming an associated increase in GR.

Consideration of Assumptions

The results of this simulation are a function of the assumed accuracy of GR assessment. Preliminary investigation showed that decreased accuracy of GR assessment would result in an increase in the estimated economic value of GR and a decrease in the ratio of economic values (HCW:GR). This demonstrates the importance of accurate drafting and the usefulness of an accurate objective measure of GR in the live animal (Kirton, et al. 1991b).

The results presented here are dependent on the assumed initial distributions of HCW and GR as well as the growth rates. If initial mean GR or GR growth rate is increased with no change in HCW the advantage of the Lean flock over the Average flock will increase. The REVs were calculated for a specific situation and may not be applicable for flocks with substantially different means or growth rates.

The assumptions with respect to feed supply being depleted may not be applicable in some situations. The Lean and Heavy flocks would have had greater returns if they had been fed for a longer period. If a lamb producer expects to deplete the feed supply before lambs have reached their potential, he may decide to sell some store lambs early in the season. The simulation does not account for that management strategy.

The valuation of all lambs on the same schedule regardless of when they were drafted is not realistic. However, season was never a significant source of variation for the ratio of economic values, suggesting that the relationship between rewards for increased carcass weight and penalties for fatness did not depend on season of the year. The observation that the estimated ratios were more variable in months of the year when there were fewer lambs being slaughtered (June to November) suggests that market signals with respect to HCW and GR were not as important to the meat companies as throughput considerations in these months.

Application

The difference in REV estimates between regions of New Zealand has implications for selection decisions. This analysis has shown that market signals were suggesting that more emphasis should be placed on selecting for increased HCW for North Island breeders relative to South Island breeders. The reason why this difference exists may be due to different populations of carcasses marketed in these regions. This study was comparing the same populations of carcasses regardless of region. Over the three years, 1987/88 through 1989/90, the proportion of T and F class lambs was lower in the South Island than it was in the North Island. The market signals may be influenced by the population of carcasses. If the South Island population of carcasses had a proportion of T and F class carcasses similar to the North Island, the REVs may change to be more like the North Island REVs. The available data is not sufficient to answer the question: To what extent does the population of carcasses affect the REV differences?. From the viewpoint of a single producer this is not a relevant factor, as long as the

individual does not have a large enough share of the population to significantly affect the regional class proportions. From the viewpoint of a region, the REVs used in breeding programs should be evaluated periodically in order to take into account the changes in class proportions as the population changes as this may have an effect on price differentials between classes.

CONCLUSIONS

The REVs for carcass traits vary in association with the price differences across category boundaries in the New Zealand export lamb schedule. The means of HCW and GR, and therefore the proportions of carcasses in specific categories, have an effect on the estimates of REVs. The drafting that is applied, will be an important factor in determining the class proportions and will influence the REV estimates.

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Estimation of relative economic values in sheep breeding programmes

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INTRODUCTION

The New Zealand sheep industry is characterised by a relatively small number (c.2 500) of farmers who breed and sell rams to a relatively large number (c.38 000) of commercial producers. This industry specialisation has important genetic repercussions. Genetic progress is almost totally dependent on the progress made in the ram-breeding flocks since selection pressure is far greater for rams, and because selection among commercial ewes does not influence the ram breeding flocks. (Clarke and Binnie, 1981) Figure 1 shows that the genetic merit of the commercial flock lies two generations behind that of the ram-breeding flock.

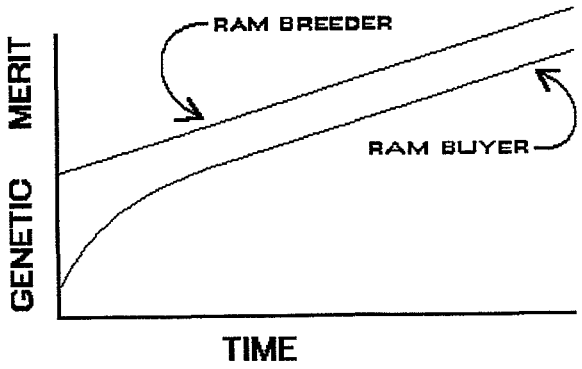


Figure 1:Genetic Dependance of Ram-buying Flock on Ram-breeding Flock.

If the ram-breeding flock is not making genetic progress in traits of economic significance to the commercial flock, then the genetic progress in the commercial flock is also zero. The future genetic merit of the New Zealand sheep industry therefore relies on the adoption of sound breeding programmes by a small number of ram breeders. It is useful to compare the five sequential steps involved in establishing an effective breeding programme.

1. Definition of the breeding objective and its component traits.

2. Choice of the most appropriate relative economic values for each of the traits in the objective.

3. Choice of records for use as selection criteria from which to estimate the breeding value of each animal for each of the traits.

4. Accurate collection and processing of these performance records to estimate the breeding values, and thus to rank the animals in terms of their value as potential parents of the next generation.

5. Use of the breeding values for selection and mating decisions. (Ponzoni,1988)

Relative economic values (REVs) are used to give relative emphasis to each of the objective traits in a manner that will result in maximum overall financial progress. Each REV represents the independant effects on profit of a unit change in the trait. Each of the component traits in the objective is multiplied by its REV, and the results are summed to give the aggregate objective (H). Hence, **H** =

REV_1*Lifetime $produc^n_1$ + REV_2*Lifetime $produc^n_2$..... + REV_n*Lifetime $produc^n_n$

The breeding values are estimated from records of the performance of the animals (and, often, of their relatives), and take into account the heritability of the trait, and its genetic and phenotypic correlations with the other characters that are measured. They can then be combined into an index of overall merit (I) that maximises the correlation between H and I.

$\mathbf{I} = REV_1*BV_1 + REV_2*BV_2 ..... + REV_n*BV_n$

Selection can then be concentrated on a single assessment of merit that recognises and accounts for the relative strengths of each of the components of the aggregate objective.

Great care must be taken to ensure that each REV reflects the correct relativity between expression of the breeding value, and expression of the objective. For example, the objective may be for lifetime wool production per ewe in the flock, whereas the breeding value is expressed as response in fleece weight only at the hogget stage. The REV must make proper allowance for these differences of expression.

THE NEED FOR DEVELOPMENTS TO REV TECHNOLOGY

Steps 3 and 4 have been well-catered for in NZ since 1967, firstly by the National Flock Recording Scheme, then by Sheeplan, and most recently by Animalplan. These schemes have become more sophisticated in their ability to handle different objectives and selection criteria. But breeders have not had equivalent tools to collate the relevant information that is available to personalise their breeding focus to the needs of their clients. They have been given very little guidance on the economic consequences of different breeding objectives. Instead, they have had to rely on somewhat crude relative economic values that have been calculated on a total industry basis, or at most, for their particular breed of sheep. Hence, Romney breeders in Southland, dryland Canterbury, and in Northland have all had their records processed in a manner that gives the same relative selection emphasis to each of the traits in their objective with little or no regard for the regional production and marketing circumstances of their clients.

Until recently, deriving separate REVs in any greater detail than this has been limited by the traditional focus of many breeders, and their access to appropriate information and processing technology. Increased acceptance of computer technology has now made this possible, and processing algorithms have been developed that will allow breeders to personalise this aspect of their performance recording analysis.

While this will undoubtedly allow selection emphasis to be apportioned in a more efficient way to match the production and market circumstances of their clients, a major advantage will come from breeder confidence in the system.

Until now, the fact that breeders have been constrained to the use of such global REVs has meant a lack of confidence in using the indexes for animal selection. They have therefore resorted to relying on doing their own assessments of the relative importance of individual breeding values. The result has been a lack of consistency in assessment of alternative candidates for selection both within, and especially between years. When this situation can be overcome by breeders choosing REVs that are personalised to their programme (based on the situations of their clients), there is clear evidence that they will significantly increase their reliance on index selection.

CALCULATION OF RELATIVE ECONOMIC VALUES

The relative economic value of a trait is the amount by which the net financial return from the animal is increased by improving that component objective by one unit on the assumption that other components of the objective are held constant. i.e. It is based on a multiple regression concept. Hence, the REV for fleece weight is defined as the extra revenue derived from an extra kilogram of wool in the animal's lifetime, minus any extra costs associated with obtaining that extra kilogram of wool.

Estimating REVs is a three-step process.

1. Specification of the production and marketing system pertaining in the commercial flocks.

2. Identification of sources of income and expense.

3. Calculation of profit equations for each of the traits of interest.
(Ponzoni, 1986)

SPECIFICATION OF PRODUCTION AND MARKETING SYSTEM

It is important to undertake a complete stock reconciliation, including all stock purchases, sales and retentions. Wool production, slaughter weights and grades, store sale weights, and lambing percentages must also be specified. These data must be documented, not only for the present situation, but also for each situation where a unit increase is assumed to have been achieved in each of the objective's component traits.

Since animal breeding does not bear results until some future time, current and historical data are used in an attempt to predict future situations. The most common approach, therefore, is to use rolling five-year averages to indicate production and market trends.

IDENTIFICATION OF SOURCES OF INCOME AND EXPENSE

All product prices, marketing costs, and production costs of relevance to the objective traits need to be specified. As in the case for specification of the production and marketing system, these need to be determined, not only for the present production system, but also for the changed future situation.

CALCULATION OF PROFIT EQUATIONS

The profit equations that have been derived for two common objective traits in New Zealand sheep flocks are shown below. They have been derived using a gross margins approach to the analysis of profit as "Extra returns - Extra costs associated with a unit change in each trait."

1. Greasy fleece weight.(GFW)

$PROFIT_{GFW}$ = [0.28kg(Price/kg of lamb wool-selling costs)
+1.00kg(Price/kg of hogget wool-selling costs)
+1.28kg*Av.no.lambs^{gs}(Price/kg ewe wool-sells costs]/[Av.no.lambs^{gs}]

+1.00kg*No wether hoggets/ewe(Price/kg hogget wool-selling costs)
+1.28kg*No wethers/ewe(Price/kg wether wool-selling costs)

Here, the objective is to increase greasy fleece weight from all animals in the flock. To maintain the correct relativity between economic values for different traits, a common basis of value per ewe per year has been chosen. Therefore the REV for fleece weight will be the net profit derived from one extra kilogram of wool produced in a ewe's lifetime.

Research evidence suggests that when hogget fleece weight increases by one kilogram, there will be concurrent increases of 0.28kg in lamb fleece weight, and 1.28kg in ewe fleece weight. This relativity has been used to calculate the REV_{GFW} for one kilogram of fleece weight per ewe lifetime.

2. Number of lambs born.(NLB)

$PROFIT_{NLB}$ = [Extra lambs weaned/ewe] *
[(Prop^{n} lambs shorn*fleece wt/lamb(Price/kg-cost)-Shear^{g} cost/lamb)
+(Prop^{n} sigtd(Net works price/lamb-Transport cost))
+(Prop^{n} store(Net store price/lamb-Transport cost))
-Husbandry cost/lamb]

In this case, the objective is to increase the number of lambs born per ewe. Profit will come from the wool produced by the extra lambs, and from the sale of extra surplus stock. In this model, it has been assumed that all the extra lambs born and surviving to sale will grow at the same rates as the present lambs, and be marketed at the same ages, and in the same proportions, as the current lambs.

ESTIMATING FEED COSTS

A cost of particular interest for the objective of Number of lambs born is that of the extra feed requirement of the more highly prolific ewe. Since the extra prolificacy has come about without any change in the other traits, the ewe will still be the same live weight, so there will be no extra feed requirement for maintenance. But there will be an additional intake over lactation, and the extra lambs themselves will consume more feed. The approach taken for New Zealand is to assume that commercial farmers regard their farms as being fully stocked at present. Therefore the extra feed reqirement caused by the genetic improvement in production will need to be accommodated by reducing stocking rate.(Jones, 1982) Accordingly, the decision-support software tool, Stockpol (McCall, 19) is used to calculate whole-farm feed requirements before and after genetic improvement of reproduction rate. The REV for NLB is then calculated as

REV_{NLB} = [$PROFIT_{NLB}$]*
[1-(Feed after change - Feed before change)/Feed before change]

In theory, all REVs should be reduced in a similar way, but in practice the reduction indicated by Stockpol analysis is less than 0.5%, and so has been ignored.

PERSONALISATION OF RELATIVE ECONOMIC VALUES

The New Zealand Meat and Wool Boards' Economic Service annual Sheep and Beef Farm Survey presents data for each of eight farm classes. Using the data from the appropriate farm class can therefore be more specific than an overall national average. However, with the aid of computer software, it is possible to be even more specific by nominating the percentage of a breeder's clients that are aligned to different farm classes and to calculate a weighted average based on this distribution. Profit equations can then be evaluated on this basis.

It is also possible to estimate the genetic progress that will result from the use of these REVs. This additional step allows the breeder to consider the expected genetic changes in the flock's physical characteristtics. It can be very salutory in terms of highlighting the important associations between productive changes and their likely economic consequences.

Further personalisation can be gained by allowing the breeder to increase the selection pressure on one component objective at the expense of another. e.g. by increasing the relative emphasis to be placed on fleece weight at the expense of reproductive rate. The corresponding new REVs can be calculated and used as input data for the genetic ranking process on which selection decisions should be based for optimal, and cumulative progress towards the chosen goal.

DISCUSSION

The technology of calculating REVs is still developing, and several assumptions and critical areas deserve discussion.

REPEATED EXPRESSIONS

Different objective traits are expressed by the animals at different ages, and different numbers of times, in their lives. e.g. Improvement in Number of Lambs Born is expressed only by females, and usually not until they are two years old, and then each year that they remain in the flock. Fleece weight, on the other hand, is expressed by both sexes, each year that they are present in the flock, and usually starting at four to six months of age. It may be important to maintain a correct time relativity in assessing the REV of different traits and to discount to the same base time. (Ponzoni, 1989) This is particularly so for traits which are expressed later in the animal's life than for traits which are expressed early. So far, discounting to adjust for these differences of expression have not been built into the estimation of REVs for the New Zealand situation.

FEED INTAKE

At present, New Zealand models either ignore the effects of increased feed intake on net profit, or take the reduced stocking rate approach. The decreased stocking rate approach does not allow for the possibility that increased feed demand in seasons of pasture surplus may actually increase feed quality. In spring, for instance, control of high pasture production can trigger better animal and pasture performance by increasing leafy, vegetative herbage rather than allowing stem and seed-head production. Rae (1988) examined the effects of making allowance for this on REVs and the consequent expected genetic gains. He found that for a defined North Island hill country situation the change in REV for full reduction in stocking rate (36%) to no reduction (0%) reduced annual genetic gain in NLB by about 40% and increased gain in fleece weight by about 16% with virtually no change in genetic gain in live weight at 8 months. Rae noted that effects of this magnitude are usually more important than changes in prices for products being sold.

An alternative to the reduced stocking rate approach is to include feed intake of the ewe and the lamb in the objective.(James,1982, 1986) However, to do so requires estimates of heritability of intake, and phenotypic and genetic correlations with other traits in the objective. Good information is not available, and is not likely to be for some considerable time yet.(Ponzoni, 1988) It would

also require estimates of the cost of pasture production derived from interest on land value, rates, fertiliser, weed and pest control, all of which are highly variable from farm to farm.

OBJECTIVES FOR DISEASE RESISTANCE OR TOLERANCE

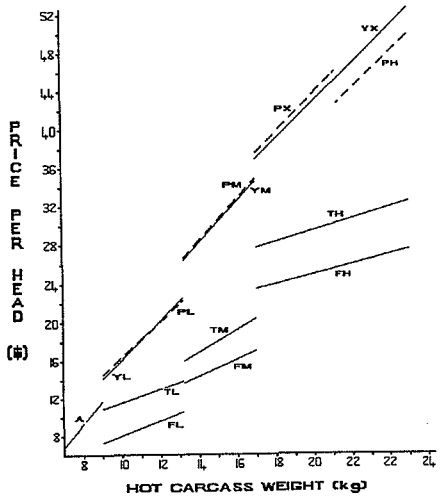
Objectives for lowering costs associated with animal health are becoming increasingly common in breeding programmes. Resistance or tolerance to internal parasites and facial eczema are the two most widely sought. While heritability estimates are available for indicator traits thought to be associated with both, information on their correlations with other traits in the objective are still to be quantified.(Blair, 1992) Costs and returns from facial eczema control are reasonably well documented, but there is considerable debate and uncertainty over similar data for parasite control. This is largely concerning the effects of parasitism at levels commonly tolerated under normal farming conditions where production responses to freedom from parasites are often zero or very small. However, deaths and dramatic loss of production from heavily parasitised animals, and the increasing incidence of drench resistance lend support to the inclusion of breeding for resistance or tolerance in programme objectives.

OBJECTIVES FOR MEAT PRODUCTION

There is much emphasis being placed on increasing the genetic ability of sheep to produce lean, heavy carcasses. Increasing the amount of lean and decreasing the amount of fat are antagonistic. Selecting for increased weight of lean alone will result in an associated increase in fat for animals of the same age. Conversely selection for decreased weight of fat will result in decreased lean production. Compromises are possible. By accepting less than maximum progress in weight of lean, the increase in weight of fat can be significantly curtailed. Market signals and associated indexes to optimise the combined pursuit of these two objectives are being developed. (Clarke et al,1992; Waldron,This conference)

There is also considerable difficulty in obtaining accurate price information for individual farm circumstances. Payment for slaughter lambs depends on the weight and estimated fatness of the carcasses. Figure 2 shows typical returns for carcasses of different fatness grades and of increasing carcass weight.

The optimum balance between increasing lean and limiting or decreasing fat depends on where the current slaughter lambs fall on the grading grid, as well as on the prices associated with a particular schedule. For production systems that produce lambs that are lean and light (e.g.YL grade) maximum increase in returns will result from heavy emphasis on increasing carcass weight (i.e. increasing lean and accepting the concurrent increase in fat) relative to fat and heavy carcasses (e.g.PX grade) where maximium returns will result from a more conservative pursuit of increasing lean in order to limit the increase of fat so that the penalty grades are avoided.



GR of Y grades = 0- 6mm

GR of P grades = 7-12mm

GR of T grades = 13-15mm

GR of F grades = 16mm & over

Figure 2:Meat Returns Per Head For Lambs of Differing Carcass Weight and Fatness.

The returns from the marginal kilogram of carcass weight in each of these situations is difficult to estimate under the present price reporting system. Each processing company has its own schedule payment structure based on returns from the sectors of the international market it supplies, its internal cost structure, and the seasonality of supply of carcasses to the desired specification for its markets. The task of deriving appropriate price signals from the available data requires careful study. It is the subject of a companion paper by Waldron. (Waldron, 1992)

SUMMARY

Genetic progress in the New Zealand sheep industry is almost totally dependent on the adoption of sound breeding programmes by a small number of farmers specialising in ram breeding. For rapid industry-wide progress, ram breeders must focus their emphasis on the production and marketing realities of their clients.

Resources for the choice of records to use as selection criteria, and the processing of these records to estimate breeding values from which to rank animals for their value as potential parents of the next generation, are well accommodated by Animalplan. But breeders have not, until recently, had equivalent tools to collate the relevant information that is available to personalise their breeding focus to the needs of their clients. Increased acceptance of computer technology has now made this possible. Processing algorithms are being developed that will allow breeders to personalise this aspect of performance recording analysis.

However some features of these algorithms require discussion. In particular are methods appropriate to assessments of:

- the effects of variation in the number of expressions of different traits
- the effects of variation in feed intake due to genotype
- genetic improvement of disease resistance or tolerance
- market indicators for increased carcass weights and against the associated propensity for increased fat

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NONTARIFF BARRIERS TO THE MEAT TRADE IN PACIFIC BASIN COUNTRIES: A POLITICAL ECONOMY APPROACH

by

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Sanitary and phytosanitary measures (SPS) are an important component of the current negotiations in the Uruguay Round of GATT. With respect to agriculture, the "negotiations shall aim to achieve greater liberalisation of trade ...and bring all measures affecting import access and export competition under strengthened and more operationally effective GATT rules and disciplines...". This aim is to be achieved by: a reduction of import barriers; an improvement in the competitive environment through reductions in the use of "all direct and indirect subsidies and other measures affecting directly or indirectly agricultural trade"; and minimising the effects of sanitary and phytosanitary regulations.

SPS measures have the potential to seriously restrict trade in agricultural products; these measures have been introduced on a domestic basis over a long period to protect the health of consumers, livestock and plants. International agreement can ameliorate the worst effects of such measures by standardisation procedures, common use of risk measures and agreed appeal procedures.

This paper traces recent discussions in the GATT and sets out a political economy framework in which the issues can be discussed. Examples are drawn from measures in use for trade in meat and meat products in the Pacific Basin region.

Background

The GATT articles, adopted by the contracting parties in 1947, explicitly recognised the possibility that domestic health, safety and environmental policies might override general attempts to lower trade barriers. GATT Article XI, headed "General Elimination of Quantitative Restrictions" states:

> No prohibitions or restrictions other than duties, taxes, or other charges, whether made effective through quotas, import or export licences or other measures, shall be instituted or maintained by any contracting party on the importation of any product of the territory of any contracting part or on the exportation and sale for export of any product destined for the territory of any other contracting party.

Article XX, headed "General Exceptions" provides:

> ...nothing in the Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures;...(b) that enable countries to take such measures as they consider necesary to protect plant, animal and human life and health;...(g) relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption; provided such measures... are not applied in a manner which would constitute a means of arbitary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade.

GATT law also emphasises that any restrictions imposed on foreign practices for environmental or health reasons must also reflect a domestic commitment, so that the exceptions cannot be misused as a disguised form of protection (Runge 1990).

Signatories to the Tokyo Round Agreement on Technical Barriers to Trade were required to notify other parties through the GATT Secretariat of products to be covered by proposed technical regulations (GATT 1992). There have since been 211 notifications in the area of environment protection and 168 notifications in the area of public health and safety. GATT (1992) notes that as environmental awareness has increased, the use of health and safety standards has become more common. They suggest that both reduce international competitiveness; health and safety standards through nontariff barriers and environmental standards through pollution charges and the like.

The thrust to the current negotiations on sanitary and phytosanitary measures (SPS) is to establish a common set of rules and disciplines to guide the adoption, development and enforcement of sanitary measures. The virtues of transparency are stressed in the context of countries having a greater understanding of other countries problems and accepting a set of common standards in the area. It is stressed that greater international "harmonisation" of standards, rules and procedures using international scientific organisations would produce trade benefits. Better frameworks for consultation and dispute settlement would also asist. Finally, the concept of "equivalence" is being discussed whereby equivalent methods of achieving the same result are agreed (Rajasekar 1991).

The political economy approach

SPS measures are a particular form of nontariff barrier that have been recognised for many years. More recently, environmental measures have been included in classifications of nontariff barriers where they impact on border costs. These essentially domestic measures have the potential to seriously threaten international trade in agricultural products without some form of agreement. Seeking such international agreement is therefore an activity which goes beyond microeconomic concerns for

efficiency and includes the relative power of the bargaining parties, protectionism versus free trade philosophies, the role of international agencies (both in the trade area and in the scientific area), and the assembly of evidence on which to base a case, remembering that countries are permitted to take such measures as they consider necessary to protect plant, animal and human life.

This framework can be seen as a variant of the political economy model discussed by MacLaren (1991) where policy intervention is treated as an endogenous factor. Policy is seen as an outcome of the interaction of rational policy makers and trade-sensitive economic groups. The groups in the SPS case include trade officials, veterinary officials, international science organisations, professional associations, producer groups and other groups who may have a role in the delivery system of agricultural products from farm to the consumer. Some political economy writers refer to the power structure within the marketing channel (Martin *et al* 1986).

Marketing channels thus have many participants who interact with each other in the normal process of business. The power structure reflects the position and size of the participants. Channel members include those who fit into the flow of ownership and those who participate in negotiation, bargaining and arranging transactions for others (Petrey 1989).

The use of the political economy framework to describe the activity of market channels was first proposed by Stern and Reve (1980). This framework integrates economic structures and processes with socio-political phenomena. Changes in economic processes are linked to the structure and goals of the various members and the influence of external power wielders and dominant interest groups as identified above.

Petrey (1989) suggests that the classical approach to international trade lacks such a perspective. Trade barriers are erected in a political environment for domestic reasons. Thus the sharing of rewards depends not only on the market but also on bargaining, negotiation, coercion and the use of symbols (Hirschman 1980). Hirschman was also instrumental in pointing out the growth of nontariff barriers in the 1930s to supplement tariffs and customs duties.

To maintain international trade in agricultural products from the sanitary point of view alone involves all the groups in the political economy paradigm. The existing set of country by country agreements on standards have been brought about by patient negotiation and exchange of information. In this process, the official veterinarians and plant experts play a key role; they negotiate with other governments and other experts to reach agreement on export/import protocols, they also convey to producers and manufacturers the requirements for the export trade, and they even provide an inspection service to see that the standards are met.

In market channel terms these experts stand between the processors and their markets. They are part of the political and economic exchanges in the channel that involve information, legitimacy and authority. They have considerable power as their activity is backed by legislation which presribes their independence of processors, producers and exporters.

Information is thus part of the political economy paradigm in the sanitary and phytosanitary area. Human and animal health concerns are a matter of scientific evidence as much as political deliberation. Thus the final ingredient in the power structure of the channel is the role of the technical expert and the international organisations that represent them.

Experts deal in a scarce commodity, knowledge, which includes not only the knowledge they have immediate access to, but also the information they can obtain from research and analysis (Weiss 1980). The interpretations and predictions of technical experts are judged to be rational because they are based on objective data gathered through scientific procedures and evaluated through rigorous control processes (Petrey 1989). International negotiations in the SPS nontariff area must necessarily be based on such assessments and hence legitimise the role of the expert (GATT 1992).

But since the market channel has a political as well as economic components it is likely the advice of experts will sometimes be challenged (Petrey 1989). There is a role for obfuscation in such matters as well as confusion over different player's roles in the channel. In the realm of SPS measures the rules are almost entirely set in the technical environment. However, in the international environment political action is currently taking place to get agreement on a common set of codes and interpretations that will assist international trade and not hinder it.

Discussion

The objectives of the SPS negotiations are to establish a common set of rules and disciplines to guide the adoption, development and enforcement of SPS measures; to achieve greater transparency, openness and clarity; to promote greater international harmonisation of standards, rules and procedures; and to promote an improved consultation and dispute settlement framework (Raja sekar 1991).

Harmonisation of standards will encourage countries to adopt wherever possible standards and guidelines that have been adopted by international standardising bodies such as *Codex Alimentarius*, the *Organisation International Epizootics* (OIE), and the *International Plant Protection Convention*. Countries would have the right to adopt measures more stringent than those provided for by international standards but these cannot be established without reasonable scientific justification. Harmonisation will embrace more active support and participation in the international scientific organisations.

In the discussions on equivalence the objective is to obtain explicit recognition and commitment to alternative ways of achieving the same SPS objective. One country may require a particular method of preservation when there is another available. It is hoped that countries will allow each other the right to adopt measures different from their own provided that the exporting country can demonstrate that its measures achieve the importing country's level of SPS security.

As far back as the Tokyo Round it was agreed that it would be possible for an exporting country to challenge another country's ban on the sale of a particular product if the ban is not based on scientific criteria (GATT 1992). These various provisions are an attempt to find a reasonable, good-faith balance between the desire to avoid distortions to competition and the desire to allow each country sovereignty over measures affecting the health and safety of its residents. GATT says the issues are so sensitive that proper scientific evidence must always be forthcoming (ibid).

The attempt to achieve greater transparency is linked to greater use of risk assessment criteria. Greater uniformity in the assessment of risk posed by international transfer of plants, animals and their products, suggest some form of international agreement on risk assessment. The basis of any assessment should be all the available scientific evidence, relevant production and process methods and pest and disease profiles in the exporting country.

The SPS discussions are seeking to establish ground rules that are acceptable to participating countries. It is suggested that exporting countries should not have to undergo more rigorous control, testing and approval procedures than those applying to domestic producers. It is also suggested that there should be time limits on information processes and consideration of applications for new protocols. Some countries would like to have the right to apply national approval processes in all circumstances as opposed to international processes. Access to a market should be based on the relevant international standard until such time as the importing counry makes a national determination (Rajasekar 1991).

On the question of dispute settlement, improvements are also sought. More expeditious ways of handling disputes should be developed. In terms of the political economy paradigm, there is a move to involve the relevant international scientific organisations in the the dispute process, consultation and settlement. Most countries are apparently in favour of bilateral resolution of disputes as far as possible (Rajasekar 1991).

Sanitary Measures in the Meat Trade

The harmonisation of standards clearly involves considerable discussion and negotiation. The meat trade is an area where these standards have been developed to a high degree of understanding and international agreement. Petrey and Johnson (1992a, 1992b)

have reviewed the meat import requirements for meat and meat products in the Pacific Basin countries from the political economy point of view and examined the underlying reasons for the particular measures found to be in place.

Their methodology was to analyse the import restriction measures recorded in New Zealand for the following 18 countries:

Australia	Canada
Fiji	French Polynesia
Hong Kong	Indonesia
Japan	Malaysia
New Caledonia	New Zealand
Papua New Guinea	Philippines
South Korea	Taiwan
Thailand	Tonga
United States	Western Samoa

Figure 1 shows an example of the data extracted for imports into New Zealand for SPS requirements for meat and meat products. The method follows closely that of Hillman (1978, 1991). The intention is to identify the policy or practice that actually has to be observed by exporters and the background reasons lying behind the measures.

From the data in this figure and the data from the other countries studied, it is clear that there are a number of justifications for SPS regulations in the meat trade area. In summary, these are:

- threats to animal health
- threats to public health
- need for truth in labelling
- meeting consumer aesthetics
- maintaining product quality
- maintaining security in transit
- meeting customary practice (eg Halal)
- maintaining protection of domestic production
- maintaining need for market discipline
- prevention of entry into edible food chain.

These broadly equate with the overall GATT objective of protecting the health of consumers, livestock and plants in Article XX (b).

Presented in this way this particular set of nontariff measures appears to be largely justifiable. Hillman's 1978 assessment was that there was a wide range of national statutes and regulations relating to human health, animals or plant life that were justified but this did not prevent confusing and misleading assessments being made about their economic effects (Hillman 1978, p 26).

One assessment of the meat SPS measures analysed is that they are not intrinsicly wrong but are subject to wide interpretation. There is certainly scope for abuse by national agencies. This

conclusion supports the GATT initiatives for making the measures more transparent and using international fora to standardise sanitary and phytosanitary measures to lessen the chance of potential abuse in the future.

Conclusions

At the time of writing (June 1992), the Uruguay negotiations have not been completed. The SPS text has been negotiated and awaits agreement on the rest of the Round. Elements of the SPS text are already being implemented. As long as the main negotiation is incomplete, there is a risk that an SPS measure could be introduced without adequate sanctions.

The negotiators of the SPS text stress that the objectives of greater harmonisation and transparency are going to take time to achieve. There are such different stages of development throughout the world, and different country standards and approaches, that considerable time will be needed to carry the negotiated text into effect. The big issue is the different levels of development in the world and the potential to use nontariff barriers to protect existing positions.

The political economy model advanced by MacLaren (1991) provides a useful explanation of the forces behind the growth of trade in agricultural products and the potential impediments to trade that exist. The model brings out the large number of participants in the market channel that are not necessarily owners of product. It illustrates the wide role of goverments beyond mere policy formation. This particular analysis identifies the respective roles of science, scientific organisations and experts. It shows rather less political resolution of international problems and rather greater resolution at a technical level. It also indicates that all assessment of plant, human and animal health protocols are finely balanced on the available scientific evidence and that risk assessment is a crucial part of the evaluation process.

Detail of SPS protocols for the meat trade in the Pacific Basin countries show up an area where the measures have reached a fairly advanced stage of development and agreement. There is no doubt that the requirements specified do add costs to the exporting country, and importing countries have costs of inspection as well. But the positive conclusion is that there is a growing trade in meat and meat products in the Pacific Basin region which presumably satisfies all the SPS protocols laid down and overcomes the extra cost laid down by individual countries (NZ Meat News, March 11 1992).

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Figure 1: Measures for Meat in the Pacific Basin Region — New Zealand

Country	Commodity	Policy or Practise	Reason for Trade Measure
NEW ZEALAND	Meat, meat products	The following categories of meat and meat products are permitted entry: (a) Originating from the following countries or areas: Australia — UK Canada — USA Republic of Ireland — Japan EEC — Switzerland (i) Cooked meat and meat product in hermetically sealed containers which are shelf staple. (ii) Cooked meat products that have been dehydrated, e.g., 'instant' meat and chicken soups provided they are commercially manufactured and packed. (b) Meat, meat products from any country which meet the equivalent criteria for heat treated hermetically sealed shelf stable canned low acid food product. (c) Other meat products approved and listed by the Chief Veterinary Officer. (d) Meat and meat products used by airline industry: International airlines are permitted to land frozen pre-cooked or dehydrated foodstuffs containing meat/ salmon and dairy products (e.g., cheese and butter) at New Zealand airports. Any foodstuffs landed are to be bonded in the Air New Zealand flight kitchen and are solely to be used for preparation of meals in aircraft leaving New Zealand. (e) New Zealand meat rejected from an overseas market off-loaded prior to export:	Public Health/Animal Health

Country	Commodity	Policy or Practise	Reason for Trade Measure
		An import permit is required to re-import New Zealand meat rejected overseas. The Chief Veterinary Officer has approved the off-loading of New Zealand meat from export from overseas aircraft for storage at the airport until it is loaded onto a later flight or if the meat has been returned to the meat export company's cool storage. Certification requirement: - Advice when requested to Medical Officer of Health that food complies with relevant provision of New Zealand Food Act 1981 and Food Regulations 1984, Animal Act 1967, and as specified by Chief Veterinary Officer in regard to food type and country of origin.	
	Byproducts — edible (sausage casings)	Natural sausage casings of animal origin - import permitted from countries approved and listed. Manufactured sausage casings — containing synthetic materials and animal products: imports permitted from countries approved and listed. Synthetic sausage casing — containing no animal products: imports permitted unconditionally.	Public Health/Animal Health

SWOPSIM WORLD AGRICULTURAL TRADE MODEL: A PRELIMINARY EVALUATION OF THE CAP REFORM PROPOSAL

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ABSTRACT

The proposal to reform the Common Agricultural Policy (CAP) put forward by the European Community (EC) in May 1992 had received varied reactions within New Zealand. This response is mainly attributable to the difficulty in assessing the impacts of the reforms proposed for individual sectors such as cereals, meats and dairy. The greatest concern is that, due to the low level and the unevenness in assistance reduction among the different sectors of EC being proposed, this could in fact result in very small, or even negative, net trade benefits to New Zealand.

The paper first attempts to evaluate the proposed changes in the CAP Reform package in terms of producer and consumer support. Then a multi-region multi-product net trade model set up within the USDA's SWOPSIM (Static World Policy Simulation) Framework is utilised to analyse the impacts of these reforms in EC. The resulting world prices, producer and consumer prices in key countries, especially EC and New Zealand, and the consequent impacts on production and net trade are investigated.

The above analysis enabled a preliminary quantitative assessment of the impacts of the reforms in CAP on the net trade of a range of commodities of importance to New Zealand. The comparison of these trade results, with those arising from the EC-MacSharry and the GATT-Dunkel proposals of last year, confirm the lack of impetus for world agricultural trade that could be expected from the implementation of this latest proposal.

The views expressed in this paper are those of the author and do not necessarily reflect the official view of the Ministry of Agriculture and Fisheries. The development of this paper benefited from discussions with colleagues at Policy Services, particularly Richard Wallace, whose understanding of the Common Agricultural Policy and the reforms announced was quite helpful. Typing assistance of Frances Roche is also appreciated. Errors and omissions are the responsibility of the author.

SWOPSIM WORLD AGRICULTURAL TRADE MODEL: A PRELIMINARY EVALUATION OF THE CAP REFORM PROPOSAL

I INTRODUCTION

Agriculture has attained a prominent part in the latest Uruguay Round of GATT multilateral trade negotiations, which is now into the seventh year and has passed several deadlines set with the objective of bringing the Round to a successful conclusion. An important obstacle to achieving progress in the Uruguay Round had been the Common Agricultural Policy (CAP) of the European Economic Community (EC), where a multitude of assistance measures for agricultural producers have perpetuated over the years of CAP's existence.

Over the last two year period, since the passing of the first deadline of the Uruguay Round in December 1990, EC Commission has introduced two PRINCIPAL proposals to reform the CAP. The first one was put forward by the EC Agricultural Commissioner, MacSharry, in July 1991 and adopted by the Commission, but was not agreed upon by the EC Council of Ministers. The most recent package announced in late May 1992 and agreed to by the EC Agricultural Ministers was a diluted version of the 1991 proposal and contained similar reform measures for beef, but a rather different package in the area of cereals and dairy support.

In order to evaluate the impacts of these proposals on EC agriculture, on world prices and on the trade prospects for various individual countries, analysts have increasingly relied on world trade models which have a multi-region and multi-product focus. One such model is the Static World Policy Simulation (SWOPSIM) modelling framework developed by the USDA (1986), in structure similar to the Ministerial Trade Mandate (MTM) model of the OECD (1985).

II OBJECTIVES OF THIS PAPER

This paper has the following tasks or steps as its specific objectives, in order to provide an assessment of the impacts of the proposed CAP Reform measures.

(a) Provide an Overview of the SWOPSIM modelling framework and the characteristics of SWOPSIM generated models.

(b) Furnish background information on the supply and net trade position of EC, US, Australia and New Zealand, with respect to cereals, dairy and meat products.

(c) Discuss the nature and extent of the two CAP Reform proposals, in some detail, and compare them with the Dunkel proposal.

(d) Make a preliminary quantitative assessment of these reform proposals on world prices for agricultural products, as well as production, consumption, trade and prices for both producers and consumers, in the EC and New Zealand.

III AN OVERVIEW OF *SWOPSIM* WORLD TRADE POLICY SIMULATION FRAMEWORK

The SWOPSIM modelling framework follows the logic of a non-spatial price equilibrium model, which assumes that domestic and traded goods are perfect substitutes in consumption. It is a computer simulation model based on electronic spreadsheets available with micro computers. It is also based on the OECD (MTM) trade model, which is an economic model that runs on a mainframe computer system, used mainly to evaluate general trade policy impacts in all OECD member countries. But the OECD/MTM model is less flexible in accommodating sub-sets of countries and commodities of importance in trade for, or specific policies of interest to, New Zealand.

The need to measure the effects of trade barriers and domestic agricultural policies of important trading partners, on agricultural commodities of importance to New Zealand, necessitated the development of this in-house capability at the Policy Services Division of MAF Policy. The specific objectives of this research are threefold:

(a) the development of a quantitative framework for agricultural trade policy analysis;

(b) the evaluation of a range of multilateral and bilateral trade policy adjustments in agriculture; and

(c) the assessment of a series of specific issues relating to trade talks in agriculture.

SWOPSIM Model Development at the USDA

The trade policy modelling framework adopted was originally developed at the USDA - Agricultural Trade Analysis Division (Roningen, 1986). The models created by the SWOPSIM framework have an economic structure and a policy structure and reside in the country model and country policy spreadsheets, respectively. The economic structure includes constant elasticity supply and demand equations and some summary policy measures. As in any standard neo-classical net trade models, trade is the difference between supply and demand.

Linkage across products occurs via cross price relationships and technological parameters, while linkage across countries and regions takes place through domestic-international price equations and world trade (Webb et al, 1987). Policies are introduced into the model by allowing world, producer and consumer prices to diverge. This is accomplished by recognising the marketing and transport margins, the exchange rate, exchange rate transmission elasticity, a world price transmission elasticity and a constant term. Two additional equations link producer and consumer prices in each domestic market to the world prices.

The policy diversity and richness of the SWOPSIM-generated models is achieved through the price linkage equations which are based on Josling's (1981) subsidy equivalent method. This approach recognises the close relationship between domestic and trade policies and quantifies the totality of the influence of governments on the market. The separation of subsidies to the producers (PSE) from those to the consumers (CSE) allows the effects on these two groups in the economy to be evaluated. PSEs attributable to trade measures such as quotas and tariffs appear as constant terms in the producer and consumer price equations, while policies affecting domestic price margins enter the terms associated with the marketing margins for producers and consumers.

The data and parameters which define the economic structure of each country's food and agricultural sector are included in the model spreadsheets and are used to generate the supply, demand and trade equations in combination with the PSEs and CSEs transferred from the policy spreadsheets. The PSEs and CSEs associated with each policy for each commodity within each country are computed by the policy spreadsheets based on original budget data. This facilitates updating or revising the policy information used in the model without disrupting the economic structure of the model.

Policy Services Versions (MAFF and MF89) of the SWOPSIM Model

A SWOPSIM model created in 1988 using the previous version of SWOPSIM and called MAFF was available within Policy Services and had been used before for evaluating some trade liberalisation measures, such as a Grains Liberalisation Scenario in the US/EC/JAPAN (Horesh and SriRamaratnam, 1988) and the beef sector liberalisation announced by Japan (SriRamaratnam, 1989). The results of these studies had previously been presented as conference papers. During 1990 and 1991 some GATT and CAP Reform proposals/scenarios were evaluated for internal trade policy work. The data used in this model (MAFF) was based on early 1980's trade and mid 1980's price/policy information and the results thus could be used only as indicative.

A new trade model was thus developed recently using the 1990 version of SWOPSIM, in order to evaluate the effects of assistance based liberalisation scenarios on trade between New Zealand and its major trading partners and is known as MF89. This is constructed within the overall SWOPSIM framework discussed in the previous section, and makes use of the flexibility of this modelling approach to determine the country and commodity coverage. The model contains eight countries or regions. These are Australia, Canada, EEC, Japan, United States, New Zealand, South Korea and an aggregate rest of the world (ROW) grouping.

The 22 commodities covered in this version includes beef, sheepmeats, pork, poultry, (fluid) milk, dairy products (butter, cheese and milk powder), wheat, corn (maize), soybeans, and coarse grains (including barley, sorghum and millets). Some of these commodities are included because of the cross-commodity linkages (eg coarse grains, soybeans) as well as the joint nature of production (eg fluid milk), even though they may not be significant in New Zealand trade.

The supply and demand parameters (eg elasticities) used in this model are those used by the USDA, with corrections where necessary, and the production disposition (ie quantity data) is based on the 1989 USDA data base. Prices and policies (PSEs/CSEs) are also for the 1989 year. Producer prices are set at the world price plus direct payment and market support only. Assistance to value adding factors and input subsidies are excluded.

The model is solved using a set of basic programs incorporating the spreadsheet program, SuperCalc. The model spreadsheets for all the countries are used in a procedure called WORLDMOD (or COMODMOD when only a single commodity is

under consideration), to generate the solution using a full simultaneous multi-region multi-product model from country/region spreadsheets. The results are output as two components. One consists of supply, demand, trade flow and price changes as a result of liberalisation scenarios introduced. The other provides the welfare results in terms of changes in net producer and consumer welfare and taxpayer savings.

IV BACKGROUND INFORMATION ON SUPPLY AND NET TRADE

Supply or production and net trade information provided in table 1 illustrate the relative importance of US, EC, Australia and New Zealand in cereal, dairy and meat products trade and the proportion of supply from these countries being traded on the world markets. This information is for the 1989 calendar year, the latest period for which production and net trade data was available across all countries and products. Generally, it is not appropriate to use the production disposition information for any one particular year, as it will not be representative of the 'normal' situation in the different regions and for the various products under consideration. It is thus preferable to use the average information for a 3-5 year period.

Cereals

The US and Australia have traditionally been the major producers and exporters of wheat and coarse grains and the US is a major player in the corn trade as well. US exported almost 60% of its wheat production and about 30% of its corn and coarse grain production in 1989. Australia exported 76% of its wheat production and 43% of its coarse grains production during the same period (table 1). US and Australia together accounted for about 50% of the world export trade in wheat and coarse grains in 1989.

EC, on the other hand, was a net importer of all grains during the 1960s and 1970s, not just corn as shown in table 1. But due to its policy of high internal prices for almost two decades, EC has moved to a position of being a net exporter of both wheat and coarse grains, to the tune of about 20% and 10% respectively, of its production in 1989. New Zealand at present is a net importer of all grains, particularly wheat from Australia.

Dairy Products

In the US, EC and Australia, cheese is the main dairy product being manufactured, while in New Zealand, butter production is most prevalent. US is a net exporter of

butter and milk powder at about 12% and 36% of its production respectively, while it is a small net importer of cheese. EC (37% share of world trade) and New Zealand (25% share of world trade) are the major net exporters of butter, together accounting for over 60% of world exports in 1989. While New Zealand exported 96% of its butter production, EC net butter exports were only 17% of its production. In spite of exporting more than 50% of its production, Australia is not a major butter exporter, as is the case with the US (table 1).

New Zealand also exported more than 70% of its cheese production and together with the EC (30% share of world trade) accounted for about 40% of world net cheese exports in 1989. Australia produces more cheese than butter, but due to its high domestic cheese consumption, exports still less cheese than butter. EC net cheese exports also account for only about 6% of its production.

In the milk powder trade, New Zealand exports about 85% of its production, which represented a market share of about 11%, and together with EC (32%), US (10%) and Australia (5%) accounted for about 60% of world exports of milk powder in 1989. Australia exported about 56% of its milk powder production, US and EC about 36% and 30% of production respectively, during the same period.

Meat Products

US is a net importer of beef (5%), pork (4%) and sheepmeats (18%), but is a net exporter of poultry meats (4%), but traded quantities are only a small fraction of the domestic supply as the values in parenthesis indicate. US is the biggest producer of beef and poultry meat among the four countries/regions considered, while EC is the biggest supplier of pigmeat and Australia and New Zealand the major suppliers of sheepmeats (table 1).

EC is a small net exporter of beef, pig meat and poultry meat, exporting about 6-7% of its production in all three cases. But, EC is a net importer of sheepmeats, mainly from New Zealand, taking in about 18% of its production in 1989.

Australia (36% share of world trade) is the largest net exporter of beef in the world, followed by EC (24%) and then New Zealand (18%). Australia exported about 56% of its beef production and 33% of its sheepmeats production in 1989. New Zealand, on the other hand, exported about 80% of its beef production and nearly 90% of its sheepmeat production during the same period. Both Australia and New Zealand are

Table 1: Supply and Net Trade Position[1] for Cereals, Dairy and Meat Products in Some Key Countries ('000 Tonnes in 1989)

	US		EC		AUSTRALIA		NEW ZEALAND	
	Supply	Net Trade	Supply	Net Trade	Supply	Net Trade	Supply	Net Trade
I Cereals								
(a) Wheat	55,428	32,920 (59%)	82,037	19,274 (23%)	14,121	10,713 (76%)	135	-190 (-140%)
(b) Corn	191,156	60,118 (31%)	26,876	-2,450 (-9%)	202	36 (18%)	139	-25 (-18%)
(c) Coarse Grains	30,202	8,334 (27%)	62,748	6,145 (10%)	6,695	2,866 (43%)	397	-5
II Dairy Products								
(a) Butter	577	70 (12%)	1,996	343 (17%)	96	52 (54%)	246	236 (96%)
(b) Cheese	2,546	-115 (-5%)	4,753	271 (6%)	190	39 (21%)	128	94 (73%)
(c) Milk Powder	397	144 (36%)	1,500	454 (30%)	127	71 (56%)	181	154 (85%)
III Meat Products								
(a) Beef	10,633	-524 (-5%)	7,878	574 (7%)	1,565	872 (56%)	550	435 (79%)
(b) Pork	7,173	-287 (-4%)	13,786	791 (6%)	302	7	44	-2
(c) Sheep Meats	157	-28 (-18%)	1,131	-199 (-18%)	585	193 (33%)	574	502 (87%)
(d) Poultry Meats	10,106	398 (4%)	6,280	354 (6%)	406	1	55	0

1. A negative sign for net trade implies a net import situation for that commodity in the country. The values in parenthesis are net trade as a % of supply or production.
Source: USDA - 1989 Global data base

nearly self-sufficient in pigmeats and poultry meats and thus the net trade in these meat types is very small.

V REFORMS PROPOSED TO THE COMMON AGRICULTURAL POLICY (CAP) OF THE EUROPEAN COMMUNITY (EC)

The CAP Reform packages have had the general objective of reducing EC market support prices for cereals, beef, and to a lesser extent, dairy products closer to world market levels, whereby EC cereals and livestock producers would be made more internationally competitive. Instead of these price distorting measures, direct compensatory support to producers, along with acreage set-aside requirements, are expected to constrain excess cereals, beef, sheepmeats and dairy production in the EC.

As can be seen in table 2, the main elements of both the CAP Reform packages relate to EC cereals and livestock areas. Producers will receive similar or greater levels of assistance, but more of the assistance will take the form of direct payments from the government. Larger arable farms, together with beef and sheep producers, will have to comply with set-aside, herd/flock and livestock intensity restrictions respectively, in order to continue to receive the maximum per unit assistance levels.

EC Agriculture Commissioner MacSharry put forward a proposal for reform of the CAP in July 1991. The proposal was adopted by the EC Commission, but was not agreed upon by the EC Council of Ministers. Although not part of the EC GATT offer, this proposal was viewed by many then as an accompaniment that could break the longstanding US-EC deadlock over Agricultural Support (Roningen, 1992). This proposal was significant for the EC in that it proposed a fundamental change in the level and manner of EC agricultural support.

Throughout the latest GATT negotiations, one of the most difficult problems in reaching agreement has been the resistance of the European Community to reductions in support measures, in particular border protection and export subsidies (ABARE, 1992). In late May 1992, the EC reached agreement on reforms that could help to facilitate agreement in the Uruguay Round, by meeting some of the requirements of the Dunkel package. Many serious questions however, remain unresolved, which include domestic support that depend on the status of compensation payments and export subsidies, still not addressed specifically in the reforms.

Table 2: A Comparison of the Main Features[1] of the MacSharry (July, 1991) and EC Reform Proposals (May, 1992)

		MacSharry Proposal	Latest EC Package
I	CEREALS	35% cut in prices to consumers of cereals (eg: pig and poultry producers use as cereals feed).	29% cut in intervention prices; 5% cut in supply expected due to set-aside provisions.
II	DAIRY	15% cut in support prices for butter; 5% cut in support prices for SMP; 3% cut in milk quotas.	5% cut over two years in support prices for butter only; no reductions in milk quotas agreed.
III	BEEF	15% cut in prices to consumers of beef; 5% cut in returns to producers.	15% cut in intervention prices; no cut in returns to beef producers.

1 More detailed discussion of these main features and other additional provisions of these proposals are discussed in the paper. The features listed above are those used in the SWOPSIM model to study their impacts.

Cereals

The main area affected by the CAP Reform agreement is the cereals sector. While the latest reform package is aimed at reducing both the level at which market prices are supported and the amount of excess production, MacSharry's original proposal intended to cut the intervention prices, but by a slightly higher level. Reductions in target and intervention prices to cereal consumers in the EC, such as the pig and poultry farmers who use them as livestock feeds, was set at 35% in the 1991 MacSharry proposal and at about 29% in the May 1992 EC reform proposal. But the latest proposal contains detailed set-aside requirements designed to reduce production. Excess production in the EC has led to large volumes of subsidised exports and large stockpiles.

The cereals reform package included an introduction of a system of compensatory payments and an associated annual set-aside requirement for farmers, whose annual cereal production is in excess of 92 tonnes. The rotational set-aside proportion will initially be set at 15% in 1993/94 and the EC Commission estimates this requirement to

apply to 12% of EC arable farmers producing 60% of EC cereal output. The maximum extent to which a 15% set-aside factor would reduce EC cereals output is thus 9%.

In practice however, US experiences with set-aside measures suggest that individual farmers' management and physical resources, such as fertilisers, will be concentrated on a smaller area of land resulting in higher yields. This, along with the maintenance of EC farmers' incomes through the compensatory payments, will mean that the negative impact on EC cereals production is likely to be in the range of 5-6% only, following a 15% set-aside factor being applied on 12% of arable farms producing 60% of the output.

Dairy

In contrast to the reform package for cereals, where the recent proposal included some supply reduction through set-aside provisions and the earlier MacSharry proposal contained only a reduction in prices to consumers, the recent EC reform proposal for dairy contained only a 5% cut in support prices for butter over a two year period, but no reductions in milk quotas, which was part of the MacSharry proposal. The existing milk quota system is thus expected to continue, with the global quota retained at its present level and the situation reviewed at the beginning of the 1993/94 and 1994/95 seasons. MacSharry plan proposed a 3% cut in EC milk quotas. Support prices for butter are to be cut by 2.5% in 1993/94 and a further 2.5% in 1994/95 in the latest proposal, but there will be no cuts in skim milk powder (SMP) prices.

Beef

The two CAP Reform proposals are similar in the level of reductions announced in beef intervention prices. These prices are to be reduced by 15% over a three year period, starting from 1993/94, in the latest proposal. But MacSharry reform proposal also contained a 5% cut in returns to beef producers, which is not part of the latest proposal.

Some other provisions announced in the latest CAP Reform proposal with respect to beef producers, included restrictions on amounts purchased into intervention stocks above the safety net price and a reduction in the safety net price itself from 78% to 60% of the intervention price. Increases in suckler cow and young bovine animal premiums were also announced, along with an additional premium for animals slaughtered between 1 January and 30 April newly introduced, subject to some restrictions. The increases in suckler cow and young bovine animal premiums are substantial, rising from 40 ECU/animal, in both cases, to 120 and 180 ECU/animal respectively, as from 1993/94.

The restriction on the number of animals eligible for premiums have also been changed to any one of the three years 1990, 1991 or 1992 during which premiums were paid.

VI THE DUNKEL PACKAGE FOR AGRICULTURE

The Uruguay Round of GATT negotiations which were scheduled to conclude at the end of 1990, had to be extended as agreement could not be reached, particularly in agriculture. In response to a deadlock in the negotiations during 1991, Arthur Dunkel, the Director-General of GATT, advanced a reform package in late 1991 that might be used as a basis for concluding the negotiations (GATT, 1991). The Dunkel package contained commitments on reductions in support in three areas, namely market access, domestic support and export subsidies, with reductions to be implemented over six years from 1993-1999.

Some of the key elements of the package included the conversion of all non-tariff barriers such as import quotas to tariff equivalents. The total tariffs applicable to the 1986-88 base period were to be reduced by an average of 36 per cent for agricultural products as a whole, with a minimum reduction for each tariff line set at 15 per cent. Access was also to be maintained at least at the 1986-88 levels, with minimum access equivalent to 3% of the level of domestic consumption in the importing country during this period set for 1993 and expanded to 5% by 1999.

The total value of trade distorting type of domestic support measures were to be reduced by 20 per cent from the base 1986-88 levels. Budget outlays for export subsidies, on the other hand, were to be reduced by 36 per cent and the volumes of subsidised exports were to be reduced by 24 per cent from the 1986-1990 average levels. Special and differential provisions were to be made available to developing countries, which would have the option of implementing the reduction commitments at rates that were less than those mentioned above over a period of up to ten years.

The Dunkel package announced in December 1991, in between the MacSharry proposal (July, 1991) and the most recent EC CAP Reforms (May, 1992), was therefore a much more comprehensive reform proposal of a multi-lateral nature than either one of the CAP Reform proposals, with likely impacts on world agriculture also expected to be more significant and widespread.

VII AN EVALUATION OF THE CAP REFORM IMPACTS

In this section, a preliminary quantitative assessment of the recent (May, 1992) CAP Reform proposal is made, with respect to its impacts on world prices for key agricultural commodities, such as cereals, meat and dairy products. It is then compared with the impacts of the MacSharry proposal as well as the Dunkel proposal. Comparisons are also made between this and the previous EC proposal made last year (July, 1991) by the EC Agricultural Commissioner MacSharry, in terms of their impacts on EC and New Zealand producer and consumer prices, supply, demand and the net trade situation in dairy and meat products. These results have to be viewed as medium term impacts occurring over a 3-5 year time horizon, following the reforms.

The most recent CAP Reform proposal was evaluated using the latest MAF Policy Services SWOPSIM model (MF89) created in May 1992, based on the updated 1990 version of SWOPSIM and also using the 1989 global data base of the USDA. The MacSharry proposal, on the other hand, was studied last year, using a SWOPSIM model (MAFF) operational within Policy Services since 1988. The two models have minor differences in their country and product coverage. MF89 includes eight countries and/or regions, while MAFF included seven such separate regions. The additional country in MF89 is South Korea. The product coverage in MF89 is consistent with the standard 22 commodities found in all SWOPSIM generated models of the USDA, where the entire grains-oilseeds-livestock complex is represented along with cotton, sugar and tobacco.

MAFF, on the other hand, was a customised restricted model, which also included wool and represented whole and skim milk powders separately, but excluded cotton, sugar and tobacco, aggregated corn (maize) within the small grains category, and also had a reduced coverage of the oilseeds complex. The data used in MAFF, however, was also different, with early 1980's production disposition and mid 1980's prices and policies data being the basis for the simulation results. MF89 model is based on the 1989 global data which is the most updated international data base available within the USDA. But from the point of view of studying the liberalisation impacts on New Zealand trade, both wool data and the separate data on whole and skim milk powders have to be added to make this model more relevant. A recent Australian study on SWOPSIM based models included wool, but used the data for 1986 and not 1989 (ABARE, 1991).

In order to use the SWOPSIM framework, the proposed changes to the Common Agricultural Policy (CAP) in the EC, outlined in table 2 and discussed in some detail in section V of this paper, have to be incorporated in the analysis. They had to be

expressed in terms of their effects on the relevant Producer Subsidy Equivalents (PSEs) and/or Consumer Subsidy Equivalents (CSEs), if they impacted on the respective price wedges. The supply and demand shifters were used, if the proposed changes were to impact on these quantities. In areas where there was uncertainty concerning the full extent and the net impact of policy changes on assistance or production levels, conservative assumptions were adopted.

Impacts on World Prices

The first step in assessing the impacts of any reform package, within the context of world agricultural trade, is to study the nature and extent of the effects of these measures on world prices for key agricultural commodities. These prices eventuate in the medium term, after the initial impacts have worked through the world markets as well as individual countries and regions involved in that trade. The results are presented in table 3 for the two CAP Reform proposals examined in this study and are contrasted with the results of the Dunkel package implemented at two different levels in a recent study by the ABARE (1992).

The most striking aspect of the results reported in table 3 is that, the two CAP Reform proposals result in the increase of world prices for some commodities and a decrease for the others, depending on the nature and extent of reforms in the different areas. But the Dunkel package, as one would expect from a comprehensive proposal, leads to an increase in the world prices for all the commodities, without exception, and also by a significantly greater amount.

World wheat and coarse grains prices are not affected much by the implementation of the MacSharry proposal. But they increase by between 5 and 7 per cent in response to the recent CAP Reform proposal, which included set-aside provisions that were expected to reduce EC supply by about 5 per cent, while the Dunkel package would have increased these prices by at least 10 per cent and up to 20 per cent in the case of wheat. The impact on soybean prices is negative, in the case of both CAP proposals, but is very small and the results for the Dunkel package were not reported in the ABARE study.

The effects on the world prices for dairy products as a result of the two CAP Reform proposals are a contrast to the effects on cereals discussed above and are a reflection of the nature of the proposals discussed in section V of this paper. While the MacSharry proposal would have led to price increases ranging from about 7 to 15 per cent for the four dairy products reported in table 3, the recent EC proposal would lead to a small

reduction in dairy product prices, the exception being butter, where the increase in price will only be about 2 per cent. This difference is due to the 3 per cent cut in milk quotas which was part of the MacSharry proposal but not the recent EC proposal. As with the cereals, increases in dairy product prices expected following the implementation of the Dunkel package are much higher, ranging from about 20 per cent for butter and cheese and up to 60 per cent in the case of milk powders.

Table 3: CAP Reform Impacts on World Prices - A Comparison of the Recent EC Proposal and the MacSharry Plan with the Dunkel Package of Comprehensive Reforms

		Changes in World Prices Anticipated		
		MacSharry	Recent EC	Dunkel Package[1]
			(% Changes)	
I	**CEREALS/OILSEEDS**			
	(a) Wheat	0.4	5.6	11 - 22
	(b) Coarse Grains	0.5	7.3	9 - 13
	(c) Soybeans	-0.2	-0.6	NA
II	**DAIRY PRODUCTS**			
	(a) Butter	15.4	2.0	19 - 38
	(b) Cheese	7.2	-0.2	29 - 45
	(c) Whole Milk Powder	8.1	-2.0	24 - 58
	(d) Skim Milk Powder	13.3	-2.0	24 - 58
III	**MEAT PRODUCTS**			
	(a) Beef	1.1	2.8	8 - 14
	(b) Pork	-4.0	-3.0	5 - 6
	(c) Sheepmeats	-1.0	-1.9	3 - 9
	(d) Poultry	-2.2	-1.9	NA

NA Not available

1 Results are a range of world price changes arising from the implementation of the Dunkel package (two scenarios) reported in a recent ABARE (1992) study. The country/region and product coverage of the SWOPSIM model and the base period data used by ABARE is somewhat different from that of Policy Services' SWOPSIM models, MAFF and MF89, respectively.

World beef prices were to increase by a very small amount as a result of both the CAP Reform proposals of 15 per cent reduction in intervention prices, but by between 8 and 14 per cent in response to the Dunkel package. But world pork, sheepmeats and poultry prices are found to decrease slightly as a result of both the CAP Reform proposals by about the same amount (2-4%), while they are expected to increase by up to 6-9 per cent if the Dunkel package was to be implemented.

Impacts on EC and New Zealand Supply and Net Trade

As a result of the changes in world prices for key agricultural commodities reported in table 3 and discussed in the previous section, domestic prices for both producers and consumers in individual countries and regions will be altered. These changes will be different for the EC where the different CAP Reform measures themselves are initiated and for other countries where the world price changes are transmitted. In response to these price changes in the domestic markets, both producers and the consumers in each country will react according to the corresponding supply and demand (own price and cross price) elasticities for the respective products.

While the simulation results are available for all the regions and/or countries modelled separately, for the purposes of this paper, only the results for the EC and New Zealand are reported in table 4. Here again, only the percentage changes in supply and both the percentage and actual changes in net trade are reported as they are the most important impacts of interest.

EC Impacts

With regards to dairy products in the EC, the MacSharry proposal, which involved a 3 per cent cut in milk quotas in the EC, leads to between a 2 and 4 per cent reduction in the supply of EC dairy products and a considerably higher reduction in their net trade. While the reduction in the net exports of milk powders were not insignificant, both butter and cheese exports declined considerably more, by about 20 and 40 per cent, respectively. In contrast, the recent EC Reform proposal, which did not reduce the size of the EC milk quotas, cut support prices for butter by only 5 per cent and not 15 per cent and had no reduction in support prices for skim milk powder, did not have any significant impact on EC supply and/or net trade of dairy products. The exception to this was butter exports, which declined by about 7 per cent.

Table 4: CAP Reform Impacts on the EC and New Zealand Supply and Net Trade - A Comparison of the Two Proposals

(% Changes)[1]

		Supply		Net Trade			
I	EC	MacSharry	Recent EC	MacSharry		Recent EC	
(a)	Butter	-4	0.4	-19	(-79,000)	-7	(-22,300)
(b)	Cheese	-2	0.2	-40	(-84,400)	4	(10,600)
(c)	Whole milk powder	-2	0.4	-3	(-13,400)	1	(3,200)
(d)	Skim milk powder	-3	0.4	-12	(-70,600)	1	(3,500)
(e)	Beef	-1	2	-175	(-247,000)	-109	(-625,000)
(f)	Pork	6	7	1,500	(430,900)	153	(1,206,000)
(g)	Poultry	6	6	85	(246,000)	123	(434,000)
(h)	Sheepmeats	1	1	-7	(-17,800)	-27	(-53,000)
II	NZ						
(a)	Butter	2	0.3	4	(8,800)	0.3	(700)
(b)	Cheese	-1	-0.5	-0.5	(-360)	-0.7	(-66)
(c)	Whole milk powder	0.4	0.3	1.0	(891)	0.2	(31)
(d)	Skim milk powder	1.3	0.3	3.5	(4,700)	0.2	(75)
(e)	Beef	2.0	1.4	3.5	(12,000)	2.0	(8,700)
(f)	Pork	-4	-3	424	(3)	171	(3)
(g)	Poultry	-2	-1.5	-140	(0)	-121	(0)
(h)	Sheepmeats	-0.5	-2.0	-0.8	(-3,800)	-2.0	(-10,500)

1 Values in parenthesis are actual changes from different base period amounts. The base period for MAFF was 1979-1981 averages and for MF89, it is 1989.

In the case of beef, the MacSharry proposal which proposed a 5 per cent cut in the returns to EC beef producers, leads to only a 1 per cent reduction in supply, as the increase in world beef prices following the reforms in the EC market, compensated this cut somewhat. The recent EC proposal which reduced the intervention prices for beef by 15 per cent, similar to the MacSharry proposal, results in a 2 per cent rise in supply mainly as a result of almost 3 per cent increase in world prices and about 1.5% increase in Ec producer prices for beef. Nevertheless, due to the considerable increase in the demand for beef in the EC market, which followed a 15 per cent reduction in EC beef prices, beef net trade situation in the EC switches from being a net exporter to become a small net importer of beef, under both the CAP Reform proposals. The size of this change was more pronounced in response to the MacSharry proposal.

The combined effect on pork and poultry meat, of the above developments in the EC beef market and the lower prices in the world and EC cereal markets was very similar under the two CAP Reform proposals and resulted in about 6-7 per cent increase in supply and considerably higher percentage and actual increases in net exports. In reality however, any increase in EC pork exports is likely to be substantially less than what is indicated in table 4, because of foot and mouth disease constraints in key export markets. As a result, meat prices in the EC will be lowered and meat prices in other markets raised somewhat.

EC sheepmeats production is expected to increase by about 1 per cent under both CAP Reform proposals, even though the world price of sheepmeats declined somewhat (1-2%), mainly due to the reduction in cereal feed costs. The demand for, and the price of, sheepmeats within the EC is also estimated to fall slightly, as a result of the lower prices for competing meats, which leads to a reduction in EC net imports of sheepmeats under both CAP Reform proposals. The reduction in EC sheepmeat imports is however, likely to be higher with the recent EC proposal than the MacSharry proposal.

The lower EC cereal prices and set-aside programme are expected to result in a significant increase in EC consumption of cereals and reduction in subsidised exports. Results for the recent EC proposal, which are not reported in table 4, suggest that EC wheat production will be cut by about 4 per cent and consumption increased by 7 per cent, leading to a 40 per cent reduction in EC wheat exports. Similar changes in coarse grains production and consumption will lead to EC becoming a net importer, rather than an exporter.

New Zealand Impacts

The impacts in the New Zealand market for dairy and meat products arises from both the developments in the world market as well as the EC market, discussed earlier in this paper. The dairy products of interest are butter, cheese and milk powders, and the important meat products traded by New Zealand are beef and sheepmeats (table 4).

With the exception of cheese for which the increase in the world price was lower than for the other dairy products in the MacSharry proposal and the price was almost unchanged in the recent EC proposal (table 3), the supply and exports of all other dairy products increased slightly in New Zealand, under the two CAP Reform proposals, but by different amounts. Increase in butter production (2%) and exports (4%) was the most pronounced impact and occurred under the MacSharry proposal, followed by the increase in skim milk powder production (1.3%) and exports (3.5%) arising from the same proposal.

The above results are attributed to the significant increases in butter and skim milk powder prices occurring in the world market as a result of the MacSharry proposal, which cut support prices for both butter and skim milk powder in the EC. Whole milk powder production and exports also increased somewhat, but by a very small amount, and cheese production and exports declined. The recent EC reform proposal, which cut support prices for butter only, but by a smaller amount, and announced no reduction in the EC milk quotas, resulted in very minimal or negligible increases in the production and exports of both butter and milk powders from New Zealand.

In the case of beef and sheepmeats, the recent EC reform proposal once again led to a smaller increase in beef exports and a greater reduction in sheepmeat exports from New Zealand, in comparison to the MacSharry proposal. New Zealand beef production is expected to increase by 2 per cent and exports by 3.5 per cent under the MacSharry proposal, while these amounts increase by 1.4 per cent and 2.0 per cent respectively, following the recent EC proposal. Similarly, sheepmeat production in New Zealand declines more under the recent EC proposal (2%) compared to the MacSharry proposal (0.5%) and thus leads to a greater reduction in exports as well (2% compared to 0.8%).

Prices for New Zealand sheepmeat in the EC are expected to face significant downward pressure as a result of both the decline in the EC intervention price for beef, and availability of cheaper poultry and pigmeat. To retain market share, it is expected that real prices for New Zealand sheepmeat within the EC will need to be reduced. Demand

for New Zealand sheepmeats elsewhere will benefit from higher world cereal prices and reduced EC beef exports to the foot and mouth disease area. These positive effects, however, could easily be offset by an expansion of subsidised EC poultry and pigmeat exports, discussed before, in response to lower feed costs. Any benefit to beef prices in the non foot and mouth disease area from improved cereal prices is likely to be offset by the impact of cheaper subsidised EC pork and poultry exports.

Overall, the latest EC CAP reform package is likely to result in reduced returns for meat exports, where a small increase in beef exports (9,000 tonnes) will be offset by reduced sheepmeats exports (11,000 tonnes), little change in dairy product exports, including butter, and impact negatively on wool exports, if EC set-aside crop land can be used for extensive grazing and thus increase EC wool production. New Zealand cereal producers, however, could gain from a likely improvement in world cereal prices, resulting in reduced wheat imports and increased barley exports. New Zealand pigmeat and poultry producers are in turn likely to face a modest increase in feed costs and thus a decline in production which will require some additional imports of pork.

VIII SUMMARY AND CONCLUSIONS

A quantitative assessment of the implications of recent reform proposal (an agreement now) to the Common Agricultural Policy (CAP) of the European Community (EC) is attempted in this paper. In order to carry out this analysis, a world trade model, known as SWOPSIM, has been employed due to its accessibility, flexibility, and the added features of decomposition of results it provides. While studying the impacts of the latest (May, 1992) CAP Reform proposal, it was felt beneficial to compare these results with the previous EC proposal put forward by the EC Agriculture Commissioner MacSharry last year (July 1991), and also contrast them with the more comprehensive Dunkel package announced within the overall GATT negotiations.

The results reported in this paper and the conclusions made about the impacts of reforms to the CAP have to be viewed as preliminary in nature and thus are to be used as indicative only. This is necessary because of the considerable uncertainty surrounding the impact of the EC beef reforms and the cereals set-aside programme which is likely to lead to possible alternative uses of the set-aside land. Various environmental protection measures have also been adopted as part of the latest reform package. These involve aids to farmers to encourage more environmentally friendly production practices

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such as, the reconversion of arable land to extensive pasture, organic farming, water protection and afforestation.

In addition, the results from the world trade model (SWOPSIM) are medium term impacts being realised over a 3-5 year time horizon, in response to policy changes often likely to be implemented in phases over the 1993-1996 period. As phased reductions are not possible to be incorporated in the SWOPSIM model, due to its static nature, the changes were applied at a point in time. Further, the whole range of complex and often detail policy measures announced as part of the CAP Reform proposal could not be directly fed into the SWOPSIM model, as some policy measures are not captured by the PSEs and CSEs, and only the important measures related to prices and production changes were possible to implement. Thus the assumptions and the actual implementation of these policies within SWOPSIM have an important bearing on the supply, demand and net trade outcomes.

In spite of these model limitations and the uncertainty surrounding the nature of the initial policy impacts, it was possible to provide some very useful information about the relative and individual merits of the reform proposals studied, with respect to their effects on the world prices and the international trade of some key agricultural commodities of interest to New Zealand. As pointed out in the paper, both CAP Reform proposals studied do not provide sufficient impetus for world agricultural trade, as the more comprehensive and multi-lateral Dunkel GATT reform package is likely to. Among the two CAP Reform packages under consideration, the 1991 MacSharry proposal was found to be of some benefit overall, particularly from the perspective of New Zealand's trade opportunities.

The recent CAP Reform package intends to reduce EC market support prices for cereals, beef and to a lesser extent butter, closer to world market levels. It is anticipated that these measures will make the EC cereals and livestock producers more internationally competitive. Excess cereals, beef and sheepmeat production in the EC may be constrained through direct and decoupled compensatory support to the agricultural producers of EC. The most significant support price reductions in the latest proposal is in the cereals area, whereas beef intervention prices are cut by the same amount as in the MacSharry proposal. The reductions in price supports for, and the supply of, EC dairy farmers, on the other hand, were nullified to a great extent.

World cereal prices thus show a moderate improvement following the reductions in subsidised EC cereal exports. EC in fact becomes a small net importer of coarse grains

starting from being a sizeable net exporter. Despite moderate gains in world cereal prices and reduced EC exports of beef, world sheepmeat prices are not expected to show any improvement due to the offsetting impact of increased EC exports of subsidised pigmeat and poultry which is triggered by lower EC grain prices. Beef prices in the non foot and mouth disease area are expected to remain virtually unchanged. Overall, the net impact of the latest EC proposal on New Zealand export returns is likely to be negative due to the importance of sales in the EC sheepmeat market. The situation would worsen if set-aside land in the EC could be used for livestock grazing and thus wool production.

The likely potential benefit to New Zealand from the CAP Reform package is that it may enhance the prospects for the resolution of the impasse in the GATT Round. It will also condition cereal producers to receiving most of their assistance directly from the government, decoupled from their own production levels. For these gains to be realised, however, will require the various components of the Dunkel package to be strictly adhered to and the tariffication of non-tariff measures carried out honestly.

SWOPSIM World Trade Model: A Preliminary Evaluation of the CAP Reform Proposal

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MEASUREMENT OF THE ECONOMIC PERFORMANCE OF DAIRY HERD TESTING UNDER A COOPERATIVE MARKET STRUCTURE

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Dr P Shannon

August 1992

MEASUREMENT OF THE ECONOMIC PERFORMANCE OF DAIRY HERD TESTING UNDER A COOPERATIVE MARKET STRUCTURE[1]

(A paper for presentation to the Annual Meeting of the New Zealand Agricultural Economics Society, 24-26 August 1992)

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Abstract

Herd Testing measures cow production with a view to increasing economic performance by helping each farmer to decide which cows to retain and by identifying which cows and sires to mate to produce future cows and sires.

Herd Testing use cannot be optimised through normal market forces nor assessed by the application of normal accounting measures. Benefits are difficult to measure and accrue both to the individual user and to the aggregate of farmers.

This paper describes a basis for measuring the economic performance of Herd Testing and establishes the need for conducting it under a cooperative market structure.

Key words: Herd Testing, economic performance, regulation, cooperatives, measurement.

Acknowledgments

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[1] The New Zealand Dairy Board has commissioned and recently received the report of the review committee established to investigate the regulation of Herd Testing and related services in New Zealand ("Herd Testing and Related Services", MacDonald Committee Report).

[2] Tim Allison and Pat Shannon are consultants to Livestock Improvement Corporation Limited and Rob Jackson (Scientist) and Siew Kee Qi (Assistant Management Accountant) are employees. The views expressed in this paper are those of the authors.

INTRODUCTION

In the report of a recent review of Herd Testing in New Zealand commissioned by the New Zealand Dairy Board, the review committee was "firmly of the view that the first and foremost concern [in relation to Herd testing] must be to optimise genetic improvement in the New Zealand dairy herd."[3] Certainly there is no lack of adherents to this philosophy which seeks the achievement of the rate of genetic gain that provides the maximum economic benefit. And although the measurement of genetic gain is well advanced and attested, optimisation of this gain requires measurement of the economic benefit associated with various levels of gain.

This paper addresses the need to measure the economic benefit associated with Herd Testing so that optimisation of genetic improvement can be a realistic goal for it. Section I describes the nature, purpose, and benefits of Herd Testing; Section II shows how the performance of Herd Testing can be measured; and Section III considers implications for how Herd Testing can best be managed to optimise genetic improvement.

I. A DESCRIPTION OF HERD TESTING

Dairy Herd Testing is best understood as being part of a wider system of livestock improvement which aims at increasing the productivity of dairy cows.

I.A. Livestock Improvement.

The improvement of the productivity of dairy livestock centers on improving the genetic quality of future generations of cows by breeding replacement cows from the best available sires. This cycle of dairy livestock improvement is illustrated in Figure 1 below. The diagram shows that livestock improvement is achieved through:

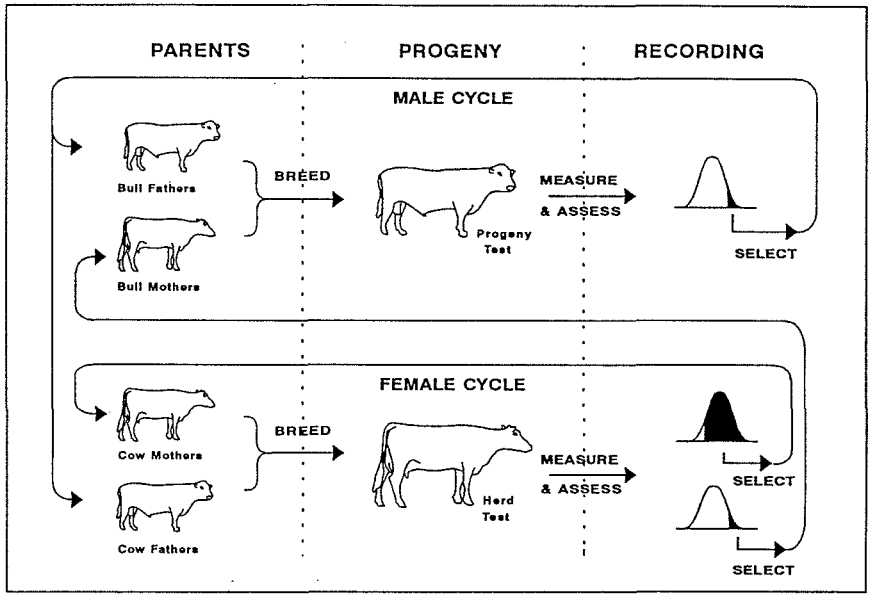
a) selection from amongst the males of the most productive bulls, using them as
   i) future cow fathers, and
   ii) future bull fathers; and

b) selection from amongst the females,
   i) of the better productive cows, using them as producers of milk and future cow mothers, and
   ii) of the most productive cows, using them as future bull mothers.

Herd Testing is the system of measurement used to rank existing cows and sires and predict the sire-dam combinations that will produce the best future sires.

[3] Herd Testing and Related Services, MacDonald Committee Report, New Zealand Dairy Board, July 1992, p.7.

FIGURE 1 - GENETIC SELECTION CYCLE



I.B. Herd Testing.

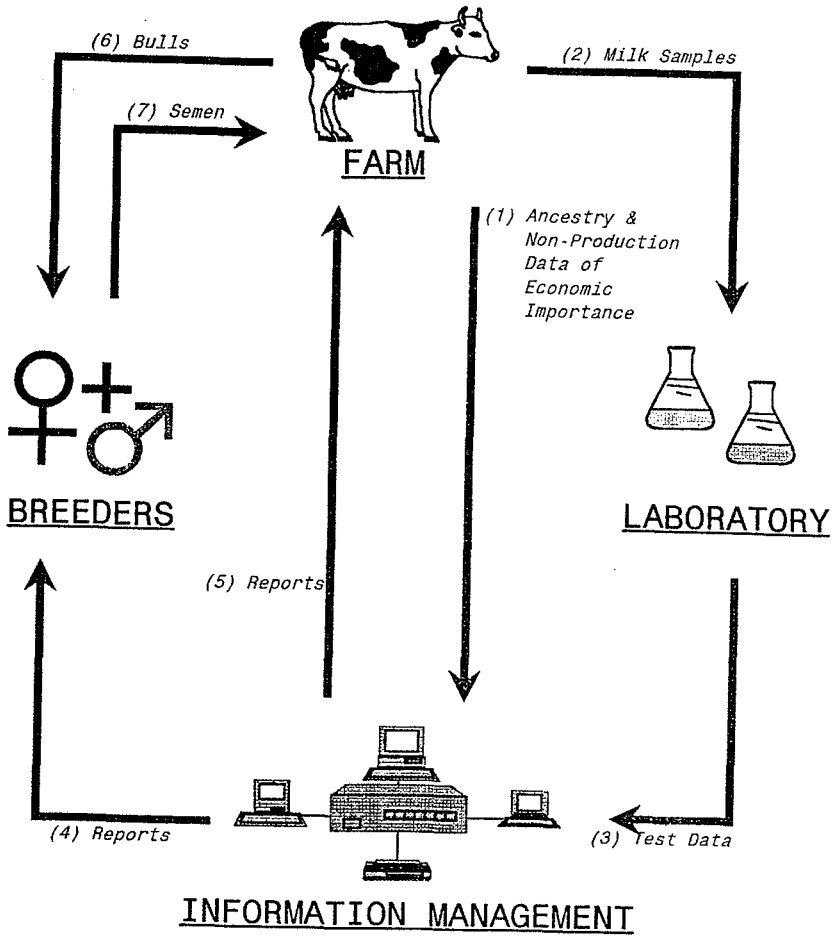
Herd Testing, then, is part of livestock improvement and is a system aimed at increasing cow productivity by measuring the performance of individual cows in order that the cow and its ancestors may be ranked in terms of their productivity. Herd productivity is increased in the short-term, by culling low producers, and in the longer term, by breeding higher producers.

The elements of the Herd Testing process are representative sampling of cow production, recording of ancestry production and other important traits, and reporting of the measurement results. Figure 2 below shows the process of the flow of the samples to the laboratory, and the flow of information based on ancestry records and sample data back to farmers and on to breeders. Herd Testing in New Zealand is currently conducted by the Livestock Improvement Corporation Limited under license to the New Zealand Dairy Board. The testing is conducted nationwide with sample analysis and computer processing centralised at Hamilton.

I.B.1. Representative Sampling.

In herds that are "tested" a representative milk sample is taken from all cows in the herd from once to twelve times a year. Increasing frequency of testing yields greater accuracy in predictions of cow and ancestor performance. The samples are analysed to measure volume of milk and the proportionate quantity of solids of value (currently fat and protein) contained.

FIGURE 2 - SUMMARY OF LIVESTOCK IMPROVEMENT



I.B.2. Recording.

I.B.2.a. Recording of Ancestry Production.
Sample results are entered into the Herd Improvement Database where the ancestry records of each cow are also maintained. Knowledge of cow and bull ancestry is critical to the assessment of potential production from existing cows and their descendants.

I.B.2.b. **Recording of Economically Important Non-Production Traits.**
Such traits as weight, temperament, and mastitis susceptibility, for example, are important in the evaluation of animals.

I.B.3. Reporting.
Using production and ancestry data a number of calculations are performed which provide indices of current production and genetic potential of sires and cows. These indices are calculated and continuously updated. The Production Index ranks a cow's current production while various Breeding Indices rank cows and bulls in terms of their breeding potential. These indices are reported to the individual farmer who has commissioned the testing as well as to the operators of breeding programmes.

I.B.4 **Notes on the Term "Herd Testing".**
Herd Testing, as it is normally known in New Zealand, is the system of sampling dairy cow milk production and recording dairy cow ancestry in order to report on the ranking of the productive and breeding value of dairy cows and sires. While the term Herd Testing focuses on the sampling process it is commonly used in New Zealand to apply to the whole process which culminates in the provision of information for making decisions that will improve livestock productivity. What is referred to as "Herd Testing", however, would be more accurately described by a term such as "Herd Recording". The former concentrates on the physical process of testing while the latter term has in view the purpose of the measurement and better reflects the crucial integration of milk sampling with ancestry records and breeding.

I.B.5 **Trends in the Use of Herd Testing.**
Dairy Herd Testing was begun in New Zealand in 1909 with the first co-operative associations for its conduct being formed in 1922.[4] Figure 3 below shows the continued increase in usage of Herd Testing. From 1955/56 to 1990/91 the percentage of dairy cows tested has risen from 24% to 68%. The reduction in the proportion of herds tested between 1986/87 and 1987/88 followed the marked decrease in returns to dairy farmers.

It is notable that the decrease in Herd Testing from 1986/87 to 1987/88 was followed by record levels of usage. During the 1990/91 dairy season, 1.566 million cows were Herd Tested[5]. The reason for the large proportion of herds that are tested can be traced to the benefits of Herd Testing which are outlined below.

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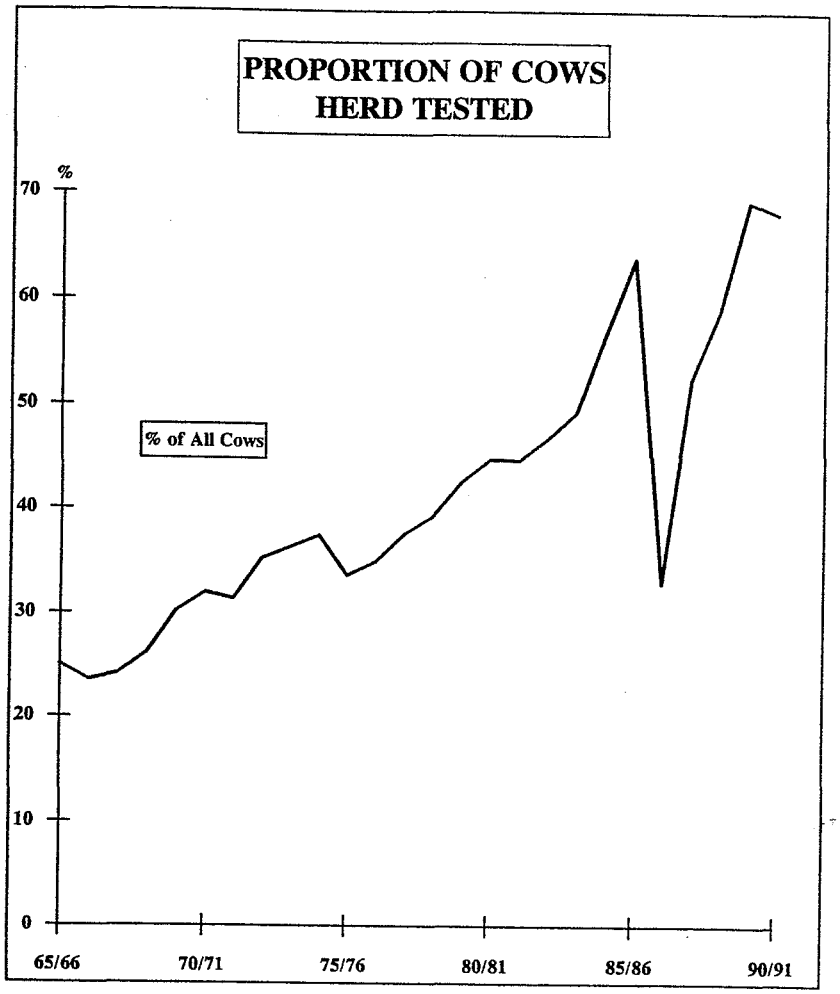
[4] Herd Testing and Related Services, MacDonald Committee Report, Appendix F.

[5] Livestock Improvement Corporation Limited, Dairy Statistics 1990/91, p.12.

FIGURE 3 - TRENDS IN HERD TESTING USE



(Source: Livestock Improvement Corporation Limited Dairy Statistics 1990/91 Page 12)

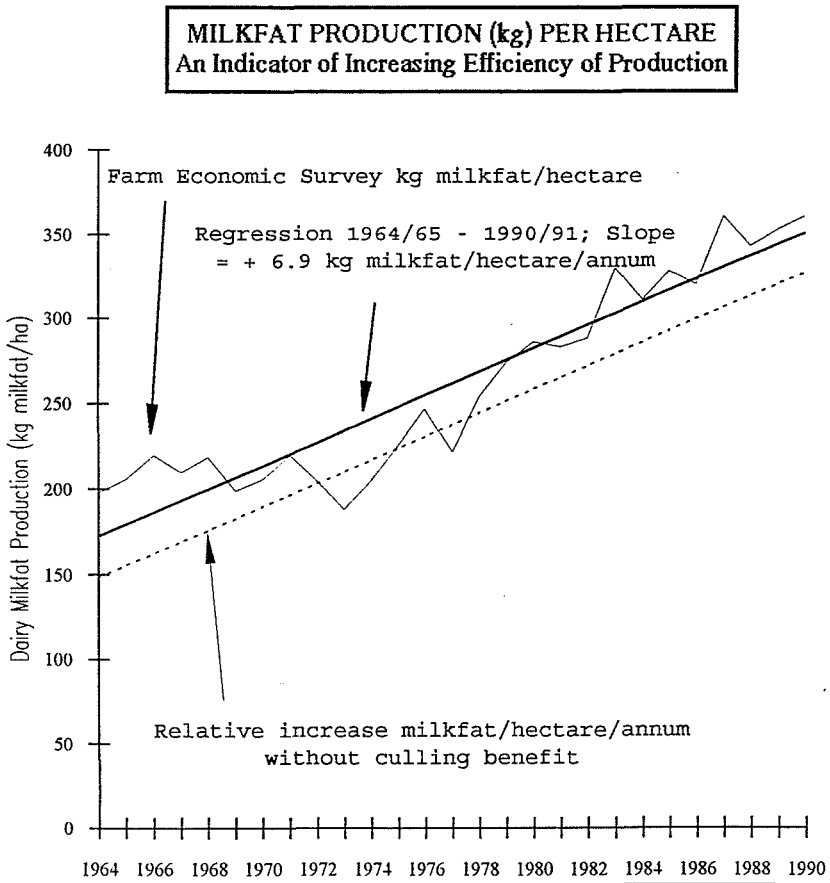
I.C. Benefits of Herd Testing.

It is widely accepted that the productivity of New Zealand dairying is increasing and that Herd Testing contributes to this improvement. The following analysis assesses the overall observable improvement in productivity and discusses what proportion of this can be attributed to Herd Testing.

I.C.1. The Overall Improvement in Dairy Farm Production Efficiency.

Efficiency of pastoral dairy farm production can be expressed in terms of output per hectare and is dependent upon pasture yield and utilisation, and conversion efficiency. Figure 4 below shows that efficiency has been steadily improving: milkfat production per hectare has increased from 198 kg for the 1964/65 dairy season to 361 kg for the 1990/91 season, a trend increase of 6.9 kg milkfat per hectare per year. However, it is readily apparent from the graph that there is a definite upward shift in the trend from the early 1970s. For the period 1972/73 to 1990/91 the trend increase is 9.8 kg milkfat per annum.

FIGURE 4



SOURCE: New Zealand Dairy Board, Farm Economic Survey, Owner Operators' Production per Hectare.

While many factors, such as fertilizer application and stock management, have contributed to this increased efficiency of production, herd testing has played a major role in the improvement of conversion efficiency.

I.C.2. Readily Quantifiable Benefits of Herd Testing in the Improvement of Efficiency of Production.

I.C.2.a. Short-term gains through culling.
In the short term the efficiency of production is increased by replacing the poorest producers.These can be identified by the "Production Index", calculated using Herd Testing information, which takes into account correction for age and other factors. Herd Testing provides information that enables farmers to cull their less productive cows so that the next season's production is increased. Early surveys of tested herds showed that this gain, which is independent of any increase through breeding, stabilised at an additional 23 lb (10.4 kg) per cow in the herd after 10 years of continuous Herd Testing[6]. The current level of production for a continuously tested herd has been confirmed at about 10 kg milkfat per cow higher than for non-tested cows[7].

Therefore, with 2.4 cows per hectare[8], this higher level of production for the Tested herd of 10 kg milkfat per cow is equivalent to 24 kg milkfat per hectare, or 6.7% of the current average production of 361 kg milkfat per hectare. While production in these herds will be increasing at the same ***rate*** as untested herds, the cows will be producing an average 24 kg milkfat per hectare per annum more than untested cows. This is illustrated by the lower parallel line of the trend in Figure 4.

I.C.2.b. Long-term gains through breeding.
In the longer term productivity is increased by using Herd Testing information to:

i) identify superior sires so that the better sires are used to the maximum possible as cow fathers and the best sires used as bull fathers; and
ii) identify superior dams so that the best may be used as bull mothers.

These longer term gains are observable by tracing the improvement in the indices measuring the genetic potential of dairy cows. Table 1 below shows that the mean Ancestry Milkfat Breeding Index (BI) of New Zealand dairy cows has increased by 1.18 BI per annum over the period 1975/76 to 1990/91. This is a reasonable estimate of the rate of change of the average Milkfat BI for New Zealand's dairy population. This increase is the result of breeding programmes which depend on ancestry records and Herd Testing information for sire proofs and for selection of dams for future sires. Because of the integrated nature of this aspect of livestock improvement, this benefit of Herd Testing must be considered as a joint product of Herd Testing and Breeding.

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6 New Zealand Dairy Board, Thirty-first Annual Report, Chairman's Report and Section on Dairy Herd Improvement in New Zealand, reprinted from the Thirty-first Annual Report of the New Zealand Dairy Board, Wellington, p.88.

7 R G Jackson, P Shannon, Herd Testing Selection Model, 1991, Livestock Improvement Corporation, unpublished.

8 Livestock Improvement Corporation Limited, Dairy Statistics 1989/90, p.5.

TABLE 1: BREEDING INDEX INCREASE FOR NZ DAIRY COWS

Breed	Mean Cow Ancestry Milkfat BI 1975[1]	Mean Cow Ancestry Milkfat BI 1990[1]	BI Change 1975-90	Annual BI Change 1975-90	Proportion of cows by Breed[2]	Weighted Average BI Change
Friesian	118.1	135.5	17.4	1.09	57.54%	0.63
Jersey	115.1	138.1	23.0	1.44	29.50%	0.42
Cross	120.5	136.7	16.2	1.01	12.95%	0.13
					100.00%	1.18

1 Source: J R Rendel, Livestock Improvement Corporation Limited, "Mean Ancestry Milkfat Breeding Index from Birth Years 1975 to 1990 for Females in the Major Breed Classes", Unpublished.

2 Source: Livestock Improvement Corporation Limited, Dairy Statistics 1989/90, p.18.

This 1.18 milkfat BI increase translates into a production increase of 1.3 kg milkfat per cow per annum or 3.67 kg milkfat per hectare per annum (see Table 2 below), or 1.0% per annum of the current average production of 361 kg milkfat per hectare. This increase is primarily the result of Livestock Improvement Corporation Limited artificial breeding which relies heavily on Herd Testing information.

TABLE 2: THE IMPACT OF BREEDING AND CULLING ON PRODUCTION PER HECTARE

Annual Change in Milkfat Breeding Index	+ 1.18 BI
Kg Milkfat per cow per Breeding Index unit	1.3
Annual change in kg milkfat per cow	+ 1.53
Cows per hectare [1]	2.4
Annual change in kg milkfat per hectare	+ 3.67

1 Livestock Improvement Corporation Limited, Dairy Statistics 1989/90, p.5.

Note that this increase in production is the mean increase for New Zealand; the contribution of Livestock Improvement Corporation alone is higher than this but its impact nationally is limited by the proportion of herds using its Artificial Breeding and Herd Testing services.

The evidence of improving productive potential shows that an increase of 3.67 kg milkfat per hectare per annum depends in part on Herd Testing which is integral with the Livestock Improvement system. This is 37% of the trend increase for 1972/73 to 1990/91 of 9.8 kg milkfat per hectare. In addition, production of continuously Tested herds will be 24 kg milkfat per hectare higher than untested herds by virtue of culling decisions being based on Herd Testing information.

I.C.3. Benefits of Herd Testing not Readily Quantifiable.

I.C.3.a. Controlling quality of production.
In addition to measurement of the solids in milk it is possible to measure somatic cells. The number of somatic cells is evidence of udder infection and assists in the management of milk quality and udder health. For the individual farmer the advantage is in better quality product and for the dairy company the benefit is that the source of poor grade milk can be traced back to the individual cow and dealt with.

I.C.3.b. Herd management.
There are a number of decisions where Herd Testing information improves productivity. Examples are which cows to dry off in drought conditions, and the appropriate stocking rate to maintain for the herd, The farmer can also use Herd Testing information to check the results of alternative management practices.

I.C.3.c. Stimulating interest in the herd.
Dr S R Searle, in a 1961 study of predicted versus observed production gains from Herd Testing, found that the observed gain exceeded that predicted, and attributed this in part to the availability of individual cow records which increased farmers' interest in their cows as individuals which led to improved stockmanship and therefore production.[9]

I.C.3.d. Providing data on dairy animals and dairy cow production.
Another benefit that is difficult to measure is that of having a database capable of providing statistics for various purposes such as:

i) Dairy Farm Extension.
ii) Research.
iii) Government statistics.
iv) New Zealand Dairy Board product development and production planning.
v) Cooperative Dairy Companies' short and long term production planning.

I.C.4. Incidence of Herd Testing Benefits.

The benefits of Herd Testing need to be classified according to their incidence since a large proportion of the measurable benefit accrues to the aggregate of farmers with attendant implications for the most appropriate market structure.

I.C.4.a Direct Benefits to individual consumers.
On farm culling and breeding decisions of direct benefit to the individual farmer are made using the Herd Testing information. The less readily quantifiable benefits of herd management, stimulated interest in the herd, and part of the benefit in quality control also accrue directly to the customer. These direct benefits are the main motivation for farmers to Herd Test at present.

I.C.4.b. Benefits to the aggregate of dairy farmers.
Under the current market structure the improvement in breeding made possible with the use of Herd Testing information accrues to all users of breeding products, whether these farmers have used Herd Testing or not. As discussed above there is a benefit to the aggregate of farmers in terms of quality control, The statistical resource made possible with Herd Testing information is largely of benefit to the dairy industry as a whole.

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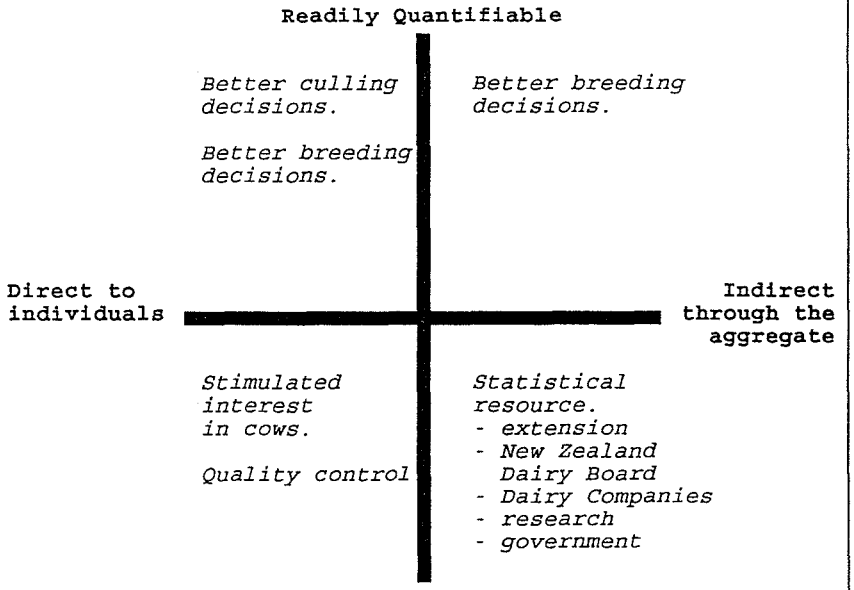
[9] Dr S R Searle, quoted in R G Jackson, "Economic Worth of Artificial Breeding and Herd Testing", New Zealand Dairy Board, Consulting Officers' Conference, 7 March 1977, unpublished.

Figure 5 below shows the classifications of the benefits of Herd Testing according to incidence and quantifiability.

FIGURE 5: CLASSIFICATION OF HERD TESTING BENEFITS



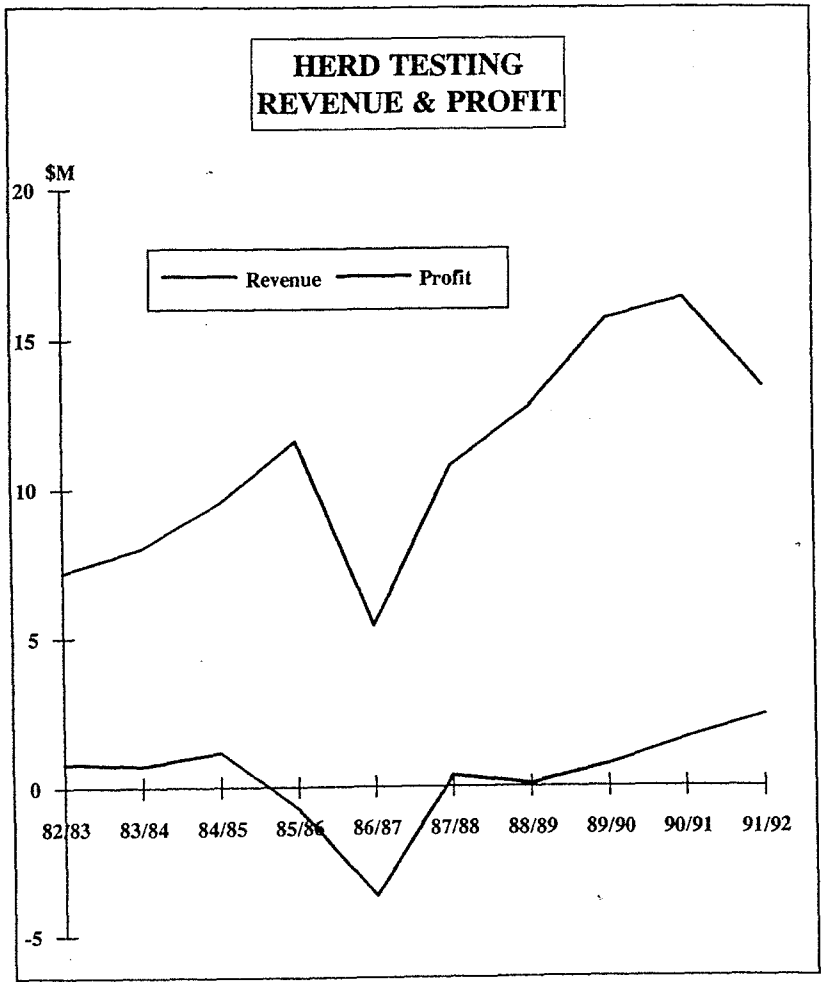
Herd Testing offers benefits of considerable variety and magnitude both directly to individual users and indirectly to users of breeding products and the dairy industry as a whole. It continues to be used by the great majority of New Zealand dairy farmers and is a major component of continuing improvement in the efficiency of dairy production. Such a product should, and indeed has, excited entrepreneurial interest. And were Herd Testing also a product that could adequately be controlled by competitive market forces it could be left to buyers and sellers to determine the quantity and quality of Herd Testing that would ensure optimum genetic improvement. At this point, a brief discussion concerning the market structure is in order.

I.D. Herd Testing Market Structure.

I.D.1. Financial Data.

The Herd Testing market is regulated and the Livestock Improvement Corporation Limited, the successor to the cooperative Livestock Improvement Associations and the New Zealand Dairy Board's Farm Production Division, is currently its sole provider. Figure 6 below shows the revenue and profit derived from Herd Testing for the years 1982/83 to 1991/92. The small level of profit, up to $3 million per annum, and losses of up to $4 million per annum, reflect the cooperative character of Herd Testing. The revenue, which is the cost to users of the service, in no way reflects its market value.

FIGURE 6



(Source: Livestock Improvement Associations and Livestock Improvement Corporation Limited Annual Reports)

I.D.2. Development of a Cooperative Market Structure.

As has been noted, cooperative associations for the conduct of Herd Testing were first formed in 1922, the initial motivation being that of a service cooperative, seeking to share capital costs between users with standardisation of measures being a logical development. But in 1931 a new dimension was added when investigation was begun into systems of progeny testing bulls, with the first official sire proofs issued in 1937.[10] The already cooperatively organised Herd Testing associations now had an added motivation for their existence, that of a variety of production cooperative, seeking to pool information and genetic material for the common good of the members.

II.D.3. Description of the Current Cooperative Market Structure.

The dual service-production cooperative nature of the Herd Testing market is illustrated in Figure 7 below.

The diagram shows the sampling, analysing and information processing aspects of Herd Testing as a servicing cooperative, with sharing of capital costs. The resulting farm input is information that enables farmers to determine which of the existing cows to cull so that next season's productivity may be increased. But the process takes on the nature of a production cooperative when farmers share their Herd Test information and their superior genetic material in the interests of achieving the best possible sires to ensure that replacement cows are more productive.

The unusual market structure that currently governs Herd Testing deserves attention because it is not a structure that has been formulated entirely deliberately, it is not a well understood structure, and nor is it well protected by either legislation or adequate academic documentation. It remains vulnerable to change that may undermine rather than enhance its contribution to the optimisation of genetic improvement.

The service-production cooperative characteristics of Herd Testing must be considered, for example, in the setting of objectives. Suitable objectives differ according to the cooperative classification. For a service cooperative, minimisation of cost subject to a level of quality is appropriate. But the level of quality provided will depend on whether or not the objectives of the production cooperative are taken into account. Additional differences in objectives will stem from the varied time horizons: that for the Herd Testing service cooperative centred around the relatively short life of capital equipment, and that of the Herd Testing production cooperative focussed on the 50 year horizon of genetic gain.

The interest to date in introducing competition into the New Zealand Herd Testing market has largely focussed on the service aspect of Herd Testing. Competition, it has been argued, might provide a cheaper Herd Testing service or one of higher value relative to the cost. But the various proposals have failed to give enough attention to the pooling of information and genetic material. The following discussion presents the importance of this "production" aspect by demonstrating its economic contribution.

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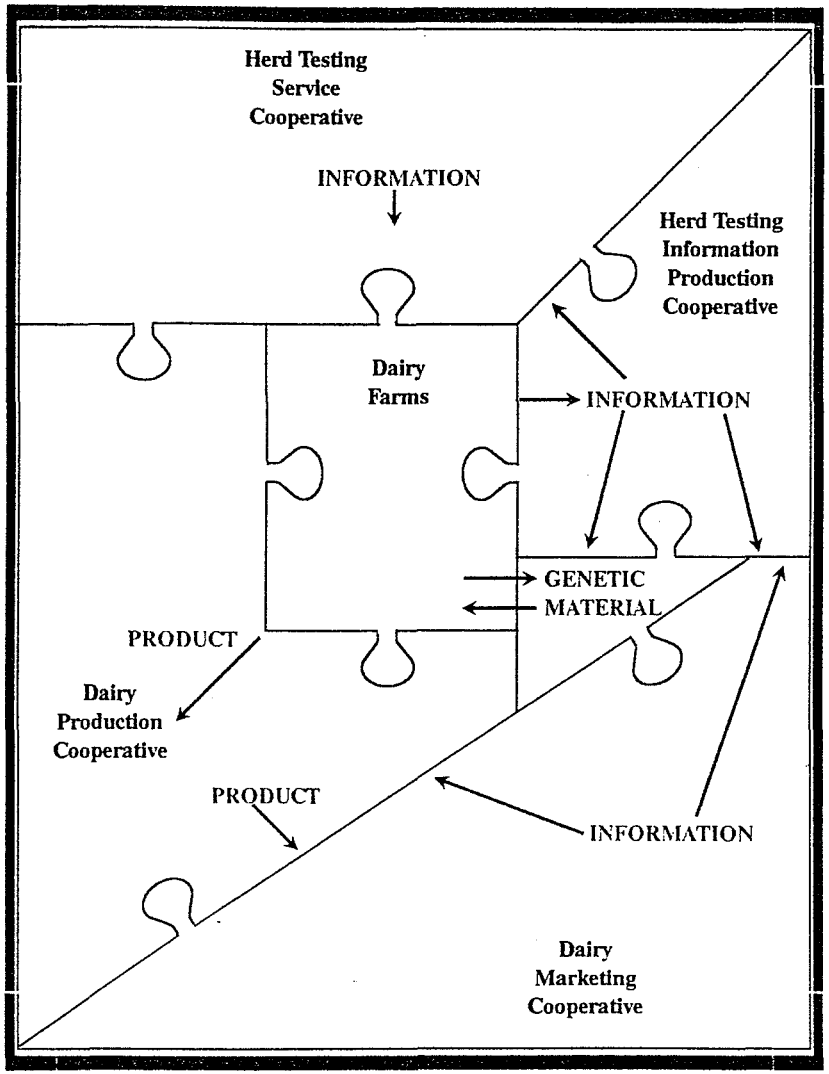
[10] Herd testing and Related Services, MacDonald Committee Report, Appendix F.

Figure 7 - Various Cooperative Elements of the NZ Dairy Industry



II. THE MEASUREMENT OF THE PERFORMANCE OF HERD TESTING

The performance of Herd Testing needs to be measured if it is to be managed with a view to optimising genetic improvement. The financial measurement of its performance is entirely inadequate since Herd Testing is operated within a cooperative market structure. A model for the measurement of the economic contribution of Herd Testing has been developed at Livestock Improvement Corporation Limited.[11] The following discussion explains the principles guiding assessment of costs, benefits, time horizon and the discount rate.

II.A.Model Assumptions.

II.A.1.Costs and Benefits.
Bird and Mitchell, in investigating the application of cost-benefit analysis in the field of animal breeding and livestock improvement, show that: "the procedures used to appraise investment projects have been biased. The result is a systematic undervaluing of future costs and benefits, and a danger of overintense selection."[12]

However, the current structure of Herd Testing in New Zealand affords a ready and accurate analysis of current and forecast costs. Herd Testing costs are accounted for by the Livestock Improvement Corporation Limited in its provision of the service. Refinements of the model may need to incorporate an imputed labour cost where farmers engage in self-sampling testing.

Herd Testing benefits are also now readily identified through the well established relationship between breeding indices and production. As has been shown, production benefits are observable and estimates verifiable. Production changes resulting from a single selection decision are traced and assumed to be repeated annually. This provides a very close approximation of the very complex cumulative production flows over many years.

For the purposes of the model a long-term average value of milkfat of $5.00 per kg was used. Taxation has been ignored on both costs and benefits.

II.A.2.Time Horizon.
The stream of benefits from dairy breeding projects occurs over a long period of time. Bird and Mitchell accept that in sensitivity analysis it may be useful to truncate the benefit stream at arbitrary points in time. However, to truncate in order to allow for risk associated with the project's benefits is inappropriate. They state that "...where truncation is used in a comparison of breeding projects, it is particularly unsatisfactory, and leads to a strong bias in favour of the project with larger net benefits within the pre-truncation period, and smaller benefits without."[13] For the purposes of this analysis there has been minimal truncation and a fifty year time horizon for production change has been used.

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[11] Livestock Improvement Corporation Limited, Summary of Livestock Improvement Corporation Limited's Contribution to the New Zealand Dairy Industry, T J Allison, R G Jackson, S K Qi, P Shannon, unpublished, 14 May 1991.

[12] P J W N Bird and G Mitchell, The Choice of discount rate in animal breeding appraisal, Animal Breeding Abstracts, August 1980, vol. 48, no. 8, Commonwealth Bureau of Animal Breeding and Genetics, p.499.

[13] Bird and Mitchell, pp.502, 503.

II.A.3. Discount rate.
Investment in the field of livestock improvement presents some special considerations in the choice of cost of capital for discounting purposes. Cunningham, for example, in discussing economic investment in livestock improvement states that: "...where the investment is on a national and widespread cooperative basis, little risk is associated with obtaining benefits and... high investment and low discount rates are justified. In contrast, in a competitive commercial environment, benefits to the investing organisation can be obtained only by higher prices for the product they sell. There are considerable commercial risks associated with the investment in this case, and higher discount rates and more prudent investment are justified."[14] Clearly the cooperative organisation of the enterprise reduces the risk premium. However, in the apparent absence of established industry estimates of the weighted average cost of capital, a real rate of return of 5% per annum was considered appropriate for discounting purposes.

II.B. Model Results.

The preceding sections have shown that milkfat production per hectare is increasing and that this is partly attributable to Herd Testing. While empirical analysis is helpful in establishing that Herd Testing is contributing towards efficiency of production, an economic quantification is necessary to fully appreciate the contribution of Herd Testing.

II.B.1. The Net Benefit of Herd Testing and Ancestry Recording..
Table 3 below summarises the model output and shows that Herd Testing information has a readily quantifiable net benefit (before tax) of $17.45 per cow per annum while the ancestry information yields another $13.49 per cow, per year, a total of $30.94 per cow per year for the integrated Herd Testing-Breeding system. Note that $18.80 per cow, or 61% of the net benefit, is not received directly by the Herd Testing customer.

The model is based on Herd Testing usage of 1.5 million cows which makes the net contribution of Herd Testing and Ancestry recording $46.4 million per annum at a price of $5.00 per kg of milkfat. With 1992/93 usage at nearly 2.0 million cows, this is an underestimate of the current net benefit. However, the net benefit is not strictly proportional to usage.

[14] E P Cunningham, Structure of Dairy Cattle Breeding in Western Europe and Comparisons with North America, Journal of Dairy Science Vol. 66, No. 7, 1983, pp.1384-5).

Table 3 - Present Value (before tax) of a Year's Herd Testing and Ancestry Recording

	$ per cow		
	Herd Testing	Ancestry Records	Total
DIRECT BENEFIT (received by Herd Testers)			
Short-term culling gain	$16.32	-	$16.32
Long-term Breeding Management	$1.84	$3.50	$5.34
	$18.16	$3.50	$21.66
DIRECT COST (paid by Herd Testing users)	$9.52	-	$9.52
DIRECT NET BENEFIT	$8.64	$3.50	$12.14
INDIRECT BENEFIT (to breeding product user)			
Breeding schemes gain	$8.81	$10.62	$19.43
INDIRECT COST	-	$0.63	$0.63
INDIRECT NET BENEFIT	$8.81	$9.99	$18.80
TOTAL NET BENEFIT	$17.45	$13.49	$30.94

Source: Summary of Livestock Improvement Corporation Limited's Contribution to the New Zealand Dairy Industry, p.2.

II.B.2. Application of the Model.
Because the model recognises the separate contributions of Herd Testing and ancestry information and the proportions that are direct and indirect to customers, it can be used to analyse changes in the alternative Herd Testing products. A common suggestion, for example, because of its reduced costs, is the testing of herds without attendant ancestry information. This is here referred to as "Labstrip Only" testing, the farmer being interested in only the results of his sample tests.

"Labstrip Only" testing would operate with the farmer using raw test results to establish the performance index for each cow using an approximate age correction factor. This information enables comparisons within age groups, providing, at best, 70% of the benefit achieved through the normal Production Index available through normal Herd Testing which includes ancestry records. Table 4 below compares the present value of this hypothetical testing option with the current system.

Table 4: An Analysis of Testing Options

	Direct Benefit: Benefit	Direct Benefit: Cost	Direct Benefit: Net	Indirect Benefit: Benefit	Indirect Benefit: Cost	Indirect Benefit: Net	Total Net Benefit
LABSTRIP ONLY TEST							
Testing	$14.44[1]	$6.50[2]	$7.94	-	-	-	$7.94
FULL HERD TEST[3]							
Testing	$18.16	$9.52	$8.64	$8.81	-	$8.81	$17.45
Ancestry	$3.50	-	$3.50	$10.62	$0.63	$9.99	$13.49
			+$12.14			$18.80	$30.94
DIFFERENCE			+$4.20			+$18.80	+$23.00

[1] Livestock Improvement Corporation Limited, The Cost Benefit of "Labstrip" Herd Testing, T J Allison, P Shannon, unpublished, 27 February 1992.
[2] The cost of sampling, and sample testing only.
[3] Livestock Improvement Corporation Limited, Summary of Livestock Improvement Corporation Limited's Contribution to the New Zealand Dairy Industry, p.2.

The table shows that "Labstrip Only" testing is much cheaper for the cow owner than normal testing at $6.50 per cow per year compared with $9.52 because costs are only incurred to the laboratory stage of the normal process. Recording and reporting costs are eliminated. But the benefit is also lower, both in terms of the direct and the indirect benefit. There is a reduced direct net benefit at $7.94 per cow per year instead of $12.14 per cow per year for normal Herd Testing. And with the cheaper testing there is *no* indirect benefit, compared with $18.80 per cow net benefit achieved with normal Herd Testing.

As discussed earlier, the major measurable motivation for testing is the direct, short-term culling gain. Here the "Labstrip Only" option has a direct net benefit $4.20 lower at $7.94 per cow per year. This is a large decrease but is still a substantial benefit which can be achieved with a lower initial outlay. But with no ancestry recording and no sharing of Herd test information this option fails to provide any indirect benefit whereas normal Herd Testing provides an additional indirect net benefit of $18.80 per cow.

On an industry basis the existing system of Herd Testing at $30.94 net benefit per cow for 1.5 million tested cows, is making a net contribution of $46.4 million per annum (before tax). The "Labstrip Only" testing would return just $11.9 million per annum (before tax).

This analysis highlights the need to consider both the direct and indirect benefits of Herd Testing. The use of economic measures of the benefit of Herd Testing is by no means new - the concept has been at the base of the development of livestock Improvement from its earliest years, certainly going back to the adoption in 1939 by the NZ Dairy Board of the Herd Improvement Plan. But analysis in the past has been relatively informal and lacking in the distinction between the direct and indirect incidence of benefits and the contribution of Herd Testing in isolation to ancestry recording.

III. THE MANAGEMENT OF HERD TESTING

It has been demonstrated in Sections I and II above that, in summary, Herd Testing has readily quantifiable benefits occurring directly to users and indirectly to all industry members; as well as other important benefits that are not so readily measurable.

Physical quantification showed that Herd Testing information is an integral part of the livestock improvement system which adds production of 3.67 kg milkfat per hectare per year (1.0%) to the dairy industry. In addition, continuously Herd Tested cows will be producing at a level 24 kg milkfat per hectare per year higher (6.7%) than non-tested cows.

Economic quantification showed that the net benefit (before tax) of a year's Herd Testing was $17.45 per cow, per year or $26.1 million per year for all tested cows. The associated ancestry recording system contributes an additional net benefit (before tax) of $13.49 per tested cow per year, or $20.2 million per year for all tested cows. The total net benefit (before tax) is therefore $30.94 per tested cow per year, or $46.3 million per year for all tested cows.

Of the readily quantifiable net benefit, only 39% accrues directly to the user of Herd Testing, the remainder is received indirectly through the use of breeding products which are improved by virtue of having Herd Test information.

The implications of these results are that:

1. Much of the benefit currently derived from Herd Testing is achieved through a cooperative market structure where Herd testing users forego direct personal gain so that the entire industry may benefit. Co-operative control of Herd Testing is imperative; otherwise, market forces will tend to maximize individual benefit based on self-interest at the expense of the benefit to the aggregate.

2. While the quantification presented here is sufficient to justify the widespread use of Herd Testing, further analysis of as yet un-measured benefits should be undertaken. No changes to the existing cooperative structure of the Herd Testing market should be entertained until all the main benefits of Herd Testing have been quantified. Any changes must be shown to enhance the already large benefits.

3. If Herd Testing is to be properly managed so that it makes the optimum contribution to the New Zealand dairy industry, an economic measurement of its performance is required. An economic model is essential for the proper measurement of the performance of Herd Testing. The prototype that has been developed by Livestock Improvement Corporation Limited needs to be refined, extended and publicly scrutinised.

4. Measurement of the performance of Herd Testing should be carried out by some party other than the provider of the service. This would be consistent with the MacDonald Committee recommendation of an audit.[15]

5. Funding of Herd Testing should be reviewed taking into account that non-herd test users benefit greatly from information obtained at the expense of Herd Testers. Safe-guarding Herd Testing from serious down-turns in usage, such as occurred in 1986/87, should also be considered. It may be advantageous for the dairy industry

[15] Herd Testing and Related Services, MacDonald Committee Report, p.40

to fund that part of Herd testing which provides benefit to the industry in aggregate and that would not accrue based on normal forces of supply and demand.

6. The term "Herd Testing" is inappropriate for the product it is intended to represent. A far more descriptive and helpful term would be "Herd Recording" which emphasises the integration of sampling with recording and associated processes.

CONCLUSION

Herd Testing and the cooperative market structure that support it, have evolved over the years to become a major contributor to the improving efficiency of dairy production in New Zealand. Because of the complexities of the principles of genetic gain and the many avenues for improving productivity, the benefits of Herd Testing remain little understood and, in the main, poorly quantified. There can be little doubt that further economic analysis of this product will show how its performance can be increased further.

C-4 AGRICULTURAL FINANCE, RISK AND RETURN

APPLICATION OF ARBITRAGE PRICING THEORY TO FARM ASSET RETURNS

G.A. Anderson, D.L. Newman and P.G. Seed.[1]

ABSTRACT: Historically, the returns to New Zealand farm assets have been relatively volatile. If total risk is accepted as the appropriate measure of risk, the observed volatility of returns would indicate that any investment in a farm asset is a risky one. However, modern portfolio theory suggests that where an asset can be included in a well diversified portfolio of assets, the relevant measure of risk becomes that portion of total risk which cannot be eliminated through diversification. Arbitrage Pricing Theory suggests that the returns to all assets are sensitive to a number of common factors, and that in a portfolio context, those sensitivities are an appropriate measure of any asset's risk. The research reported in this paper applies APT to farm assets in New Zealand, and concludes that a farm asset in the meat and wool sector has little or no systematic risk.

[1]Greg Anderson and Peter Seed are Lecturers, and Derek Newman, a Senior Lecturer in finance in the Department of Accounting and Valuation, Lincoln University, Canterbury.

1.0 Introduction

Ross (1976) proposed the Arbitrage Pricing Model, based on the Arbitrage Pricing Theory (APT), as an alternative to the Capital Asset Pricing Model (CAPM). APT is based on the notion that in competitive financial markets investors are continually seeking arbitrage opportunities, and this process should ensure that assets with the same risk provide the same expected return. If they do not, investors will buy the cheaper asset and sell the more expensive one, until prices adjust to yield equivalent expected returns. Further, the model suggests that a zero investment, riskless portfolio should provide a zero return.

In an operational sense, APT requires that the return on any asset be linearly related to a set of factors, as apposed to the single index CAPM model. Although APT is a more general equilibrium model than the CAPM, and requires less restrictive assumptions, it does not suggest what the relevant common risk factors are, the number of those factors, nor why they are economically or behaviourally relevant. It merely states that there is a relationship between asset returns and a limited number of factors which are common to all assets. One of the factors might be the excess return on the market portfolio, as in the CAPM, but this need not be the case.

If APT can be used to describe the return generating process it will also help to identify the risk sources which affect the returns. The CAPM is the more commonly used pricing model derived from portfolio theory, and suggests that asset returns are influenced by only one type of non-diversifiable risk - "market risk". In contrast APT explicitly recognises that a variety of risk factors may affect expected returns. The purpose of this study is to identify whether or not APT can be used to explain the returns to farm assets in New Zealand.

If the ability of CAPM to adequately describe farm asset returns is poor, then such a failing may be due to either:

i) "market risk" is not the only non-diversifiable risk affecting returns, or

ii) farm assets are not held in a well diversified portfolio and there are therefore other relevant and significant factors which affect returns.

The APT pricing model may therefore improve on the CAPM as it allows the inclusion of further risk factors.

2.0 Derivation of the APT Equilibrium Model

APT requires that returns are related to a set of indices, or risk factors:

$$R_i = a_i + b_{i1}I_1 + b_{i2}I_2 + \ldots + b_{ij}I_j + e_i \qquad (1)$$

with the following assumptions:

$E(e_i e_j) = 0$ ..... *for* $i \neq j$

$E[e_i(I_j - \bar{I}_j)] = 0$ ... *all indep. vars non-correlated with* e_i *terms*

$E(I_j) = 0$ ..... *needed so* $E(R_i) = a_i$

For a two index return generating process, eqn. (1) may be rewritten as:

$$R_i = a_i + b_{i1}I_1 + b_{i2}I_2 + e_i \qquad (2)$$

Taking the expected value of both sides of eqn. (2) gives:

$$E(R_i) = a_i + b_{i1}\bar{I}_1 + b_{i2}\bar{I}_2 \qquad (3)$$

Subtracting (3) from (2) yields:

$$R_i - E(R_i) = a_i - a_i + b_{i1}I_1 - b_{i1}\bar{I}_1 + b_{i2}I_2 - b_{i2}\bar{I}_2 + e_i \qquad (4)$$

which simplifies to:

$$R_i = \bar{R}_i + b_{i1}(I_1 - \bar{I}_1) + b_{i2}(I_2 - \bar{I}_2) + e_i \qquad (5)$$

Equation (5) suggests that the return to an asset is a function of the expected return, plus an unexpected return component which is due to the sensitivity of each asset to the unanticipated changes in each of the two independent variables.

The APT proof requires that a portfolio may be formed with a sufficient number of securities such that:

$\sum X_i = 0$ ..... *no investment*

$\sum X_i b_{i1} = 0$ .. *sum of all assets sensitivity to* $I_1 = 0$

$\sum X_i b_{i2} = 0$ .. *as above. i.e. no risk*

$\sum X_i e_i \approx 0$ ... *no residual risk*

$\sum X_i \bar{R}_i = 0$ .. $E(R_p) \equiv 0$, *as no risk and no investment*

thus $\underline{X}_i$ *is orthogonal to* $\underline{1}$, $\underline{b}_{i1}$, $\underline{b}_{i2}$, $\underline{\bar{R}}_i$

Using a theorem of linear algebra we can therefore represent R_i as a linear combination of a vector of b_{i1}'s and a vector of b_{i2}'s. Thus expected returns can be written as a constant times 1, and constants times b_{i1} and b_{i2}.

$$\bar{R}_i = \lambda_0 + \lambda_1 b_{i1} + \lambda_2 b_{i2} \qquad (6)$$

By substituting R_f for λ_0, the λ's can be evaluated by forming 3 portfolios:

1. $b_{p1} = 0 \quad b_{p2} = 0$

   $\therefore \bar{R}_{p1} = \lambda_0 \quad \rightarrow \quad \lambda_0 = R_f$

2. $b_{p1} = 1 \quad b_{p2} = 0$

   $\therefore \bar{R}_{p2} = \lambda_0 + \lambda_1 \quad \rightarrow \quad \lambda_1 = \bar{R}_{p2} - R_f$

3. $b_{p1} = 0 \quad b_{p2} = 1$

   $\therefore \bar{R}_{p3} = \lambda_0 + \lambda_2 \quad \rightarrow \quad \lambda_2 = \bar{R}_{p3} - R_f$

And if an equally weighted portfolio is formed from the above 3 portfolios, its expected return would be expressed as:

$$\bar{R}_{pp} = R_f + b_{p1}(\bar{R}_2 - R_f) + b_{p2}(\bar{R}_3 - R_f)$$

where $R_f = \lambda_0$, *and* $(\bar{R}_j - R_f) = \lambda_j$

Intuitively, the expected return from the combined portfolio is made up by three parts; the expected risk-free return (λ_0), and the risk premiums required to compensate for the risk added by portfolios 2 and 3. The sensitivity of portfolio 2 to changes in risk factor 1, (I_1) adds to the expected return of the combined portfolio by the amount λ_1. Portfolio 3 adds risk to the combined portfolio due to its sensitivity to risk factor 2, which is measured by b_{p2}. Similarly, the additional expected return (in excess of the risk-free rate) added to the combined portfolio by portfolio 3 is measured by λ_2.

3.0 Application of APT to Farm Assets in New Zealand

3.1 Estimation Procedure

APT may be applied in a number of ways. The return generating process can be written as:

$$R_i = a_i + \sum_{k=1}^{k} b_{ik}F_k + e_i \qquad (7)$$

and the APT model that arises from this return generating process can be written as:

$$E(R_i) = \lambda_0 + \sum_{k=1}^{k} b_{ik}\lambda_k + e_i \qquad (8)$$

where,

F_k = *factors which affect returns on all k assets (unknown)*

b_{ik} = *sensitivity of returns on asset i to factor k*

$E(R_i)$ = *the expected return on asset i*

λ_k = *extra return reqd as a result of assets sensitivity to each kth factor*

e_i = *a white noise error term*

Equation (8) is used to estimate expected asset returns, with the b_{ik}'s used as independent variables. There are however, two alternative ways of deriving estimates of b_{ik} using equation (7).

The first and most general approach is to simultaneously estimate the relevant risk factors (F_j's) and return sensitivities (b_{ik}'s) from equation (7). The estimated values of b_{ij} can then be used as the independent variables in equation (8) to estimate the λ_j's. The simultaneous

estimation of the two unknown parameters in equation (7) may be achieved using the factor analysis technique outlined in section 3.2. Alternatively, we can pre-specify the economic factors which, on the basis of extant theory, should be expected to have a significant impact on the returns to all assets. The chosen set of indices (representing the relevant risk factors) may then be used as independent variables when estimating the b_{ij}'s from equation (7), and these estimates subsequently used in equation (8) to estimate the risk premiums, λ_j.

As one of the primary objectives of this study is to identify the risk factors which have an impact on the returns to farm assets, the latter method of implementing APT is obviously more instructive. However, in order to provide a more complete study of APT, the factor analysis technique is also applied to the farm asset returns data.

3.2 Application of Factor Analysis

Factor analysis is a statistical technique used to identify factors which represent the relationships between a set of interrelated variables. The technique has been widely used in the social sciences for identifying underlying, but not directly observable, constructs, i.e., to identify the not-directly-observable factors based on a set of observable variables. APT assumes that in the capital market, shares (or assets) are the variables upon which a number of unobservable factors act. These unobservable factors are likely to be economic, political or market factors. While some studies have concentrated on trying to find the "true" number of factors[2] and their identities, other studies have concentrated on models using known factors. This study replicates the study by Chen *et al* (1986) in which the authors investigated the relationship between security returns and *known* factors which included, the rate of economic growth, the expected inflation rate, the term structure of interest rates and the risk premium. If a study uses a set of known priors based on the researchers' priors or on previous research the factor analysis stage is redundant apart from providing some information on the likely number of factors. Factor analysis was applied in this study for the latter reason alone.

Factor analysis comprises four major steps:

1. calculating the correlation matrix for the variables.
2. extracting the factors
3. rotation, or transformation, of the factors to make them more easily interpreted.
4. calculating the factor scores.

[2] For a recent new Zealand application of APT to the share market see Burgiss (1990).

The study used SPSS/PC+ to undertake the factor analysis. The analysis identified only one factor as being responsible for the return generating process; only one factor had an eigenvalue greater than one. The maximum likelihood and principle components approaches yielded the same result. Principle components analysis forms linear combinations of the observed variables. The first principle component is the combination that accounts for the largest amount of variance in the sample. The second principle component accounts for the second largest, and so on. While principle components produces the exact factor loadings, the maximum likelihood method produces parameter *estimates* which are most likely to have produced the observed correlation matrix. This result is consistent with studies of the New Zealand sharemarket, such as that by Burgiss (1990).

One of the major limitations of this study is the use of the Meat and Wool Boards' Economic Service (NZMWBES) data series. The NZMWBES data are aggregated and therefore much of the variation which would provide information about the correlations between variables has been smoothed out. As a result, much of the information on the factors behind the return generating process will also have been smoothed out. When data are highly aggregated, it is not uncommon for factor analysis to yield only one factor. Given the limitations of the NZMWBES data set, it is also unlikely any other factors could be identified unless more disaggregated data are available.

3.3 Application of Regression Analysis

Chen *et al* (1986) have hypothesised and tested a set of economic factors which could reasonably be expected to have a significant impact on the returns to all assets. Their tests suggest that at least four sets of macroeconomic influences are apparent in the return generating process. Those factors are:

1. *Inflation.* Inflation impacts both the level of the discount rate and the size of the future cash flows.
2. *The term structure of interest rates.* Differences between the rate on bonds with a long maturity and a short maturity affect the value of payments far in the future relative to near term payments.
3. *Risk Premia.* Differences between the return on safe (government) bonds and more risky (corporate) bonds are used to measure the market's reaction to risk.
4. *Industrial production.* Changes in industrial production affect the opportunities facing investors and the real value of cash flows

This study also used these four variables as the hypothesised risk factors, and their definition or source is presented in table 1.

Table 1. Glossary and Definitions of Variables

Symbol	Variable	Definition or Source
	Basic Series	
ROE	Return on Equity (Farmland)	NZMWBES Sheep and Beef Farm Survey
CPI	Inflation	Annual log Relative of New Zealand Consumer Price Index
GDP	Production	Annual Real log relative of N.Z GDP
LTG	Long-Term Govn. Bonds	Annual return on Bonds > 5yrs
STG	Short-Term Govn. Securities	Annual return on Govn. security < 1yr
TBL	Trading Bank Lending Interest Rate	Lending interest rate as at year start

While obtaining a consistent time series for all variables presented some problems, constructing a series of corporate bond returns was the most difficult. As a result, a trading bank lending rate series is used as a (barely satisfactory) proxy for this variable. Unfortunately, only a limited amount of agricultural returns data is available in New Zealand. The NZMWBES has published information from an annual survey of farmers in 8 different farm classes since 1958/59; this is the only information available from which a returns time series can be constructed. The 8 farm classes are defined in the appendix.

Most of the research relating to APT has applied the model to firms that are publicly listed. Consequently, both the number of assets and the number of periods over which returns

information is available allow far more observations than is possible in this study. For example, Chen *et al* used monthly returns from 20 equally weighted portfolios over a 5 year estimation period. In contrast we have 30 time series observations and, more seriously, only 8 observations for the cross-sectional regression (equation (8)).

The limitations imposed by the restricted data set in this study are duly acknowledged. The return on equity for each of the 8 farmland classes was measured by adding the annual farm cash surplus to any change in farm asset value during the year and dividing the sum figure by the value of the farming assets at the beginning of the year.

Estimation of equation (7) requires that the independent variables (F_j's) be expressed as unanticipated changes in the level of each variable. Before an unanticipated change in any variable can be measured, we need not only the actual realised value for any period but also the expected level in that period, where the expectation is formed at the beginning of each period. Such variables are unobservable.

Following Chen *et al*, the first differences were taken of all four variables, and these first difference series then evaluated for the degree of serial autocorrelation. If the first difference series of each variable is sufficiently uncorrelated we can then treat it as an unanticipated change, and thus validly include it as an independent variable in equation (7).

To test for autocorrelation in the independent variables, each first difference series was regressed on the two preceding lagged values. Using an F-test we then can test to see if the independent variables in this auxiliary regression (the lagged values) are statistically significantly different to zero. In all four cases we were not able to reject the null hypothesis that the regressor set is significantly different from 0. That is, the lagged values of each series do not help to determine the series of dependent variables, suggesting that the economic variables expressed in first differences can be taken as unanticipated changes.

Table 2 provides a summary of the derived series and the manner in which each variable is expressed.

The estimation procedure was as follows:

(a) The eight farmland classes' exposure to the four economic risk factors was estimated by regressing (OLS) their returns on the unanticipated changes in the economic variables over the 30 year period.

(b) The resulting estimates of exposure (b_{ik}'s) were used as the independent variables in 30 cross-section regressions (equation (8)), one regression for each of the 30 years of observations, again with asset returns being the dependent variable. Each coefficient from a cross-sectional regression provides an estimate of the sum of the risk premium, if any, associated with the unanticipated economic risk factor in that year. Thus, this step in the procedure provides 30 estimates of λ_1, λ_2, λ_3 and λ_4.

(c) The time series means of these estimates were then tested by a t-test for significant difference from zero.

Table 2. Derivation of Risk Factor Series

	Derived Series (Unanticipated Change)	
GDP(t)	Annual Growth Industrial Production	$\log_e$[GDP(t) / GDP(t-1)]
CPI(t)	Inflation	$\log_e$[CPI(t) / CPI(t-1)]
RP(t)	Risk Premia	TBL(t) - LTG(t)
TS(t)	Term Structure	LTG(t) - STG(t-1)

4.0 Estimation Results

Equation (7) was estimated for each of the eight farm classes and the resulting estimates of the reaction coefficients (b_{ik}) are presented in table 3.

Two diagnostic statistics are included in table 3. The Jarque-Bera (JB) test statistic is used as a Legrange Multiplier based test for normality on the estimated OLS residuals. It follows a chi-squared distribution, and has asymptotic properties only. The residuals must be assumed to be normally distributed before diagnostic tests for auto-correlation and parameter significance can be validly performed. Residual auto-correlation is tested for using the Breusch-Godfrey (BG) statistic, which is also a Legrange Multiplier based test with a chi-squared distribution. None of the reported test statistics from the eight estimated equations are significant which indicates the estimated residuals are normally distributed and free of auto-correlation.

Table 3. Estimated Reaction Coefficients

Asset	GDP	CPI	RP	TS	R^2	JB[b]	BG[c]
1	2.4563[a]	-0.24639	-1.6215	-0.42225	0.15	1.11	7.019
2	1.8218	0.41091	-2.7314	-1.1959	0.13	2.01	6.590
3	2.9207[a]	-0.67106	-3.4647	0.96360	0.36	0.16	10.09
4	2.9813[a]	-0.24428	-2.3531	0.51251	0.25	1.82	9.040
5	2.3367	0.03167	-2.9756	-0.6843	0.25	1.88	7.345
6	2.6172	0.33428	-2.6063	-0.8386	0.18	1.96	10.29
7	2.9811	0.70781	-1.6031	-0.2531	0.16	0.75	13.63
8	2.2316	0.71791	-5.0399	-4.1422	0.13	9.62	16.09

[a] Significant at the 90% level
[b] Critical value (0.05, df=2) = 5.99
[c] Critical value (0.05, df=9) = 16.92

Of the 32 estimated reaction coefficients, only 3 are significantly different to zero. These results are consistent with the study by Arthur, Carter and Abizadeh (1988) which suggests that U.S. agricultural returns are not sensitive to any of the risk factors used in that study. As most of the estimated reaction coefficients are near-zero, and that these are used as independent variables in the cross-sectional regression, we should expect the estimated risk premia from equation (8) to be also near zero. The mean values of the risk premia (in excess of the risk free rate) from the cross-sectional regressions were:

	Estimated Value	t-score
λ_{GDP}	= 0.0491	(1.3062)
λ_{CPI}	= 0.0082	(0.0839)
λ_{RP}	= 0.0117	(0.2853)
λ_{TS}	= -0.0172	(-0.3686)

As expected, the estimated risk premia are not statistically significantly different to zero. Clearly if the farm assets have reaction coefficients and risk premia which are all near-zero, the expected return in excess of the risk free rate will also be insignificant.

Before interpreting this result, the following constraints should be noted.

1. The study has attempted to apply the APT to agricultural assets in New Zealand, and is based on the results of the application of the same theory to equity earnings in the U.S.

   We are therefore implicitly assuming that:

   i) the return generating process in both countries is similar. i.e. the same risk factors (indices) which Chen *et al* find significant in the U.S. are also relevant in New Zealand. If this assumption is accepted as reasonable, we then must assume

   ii) that the required returns an investment in farming are determined by the same factors as those that affect the returns to all other assets in the economy and that the farm asset can be held as part of a widely diversified portfolio.

   If these assumptions are accepted, the results of this study suggest that investment in farming is relatively riskless.

2. However, it is also possible to argue that the estimated reaction coefficients are near-zero for either of the two following reasons:

   i) Data Problems. It is anticipated that all of the time series data used in the estimated equations are measured with error. The consistency of the economic variable series prior to, say 1970 may be questioned while calculating an accurate series of farmland returns is complicated by the frequent changes to the valuation basis used by the NZMWBES in their survey. It is suggested however that the main data problem is that only annual series are available. In order that a reasonable number of observations be used to estimate equation (7) the time series incorporates returns which cover a 30 year period. This implicitly forces us to assume that the set of relevant risk factors has been constant over time, with no structural change to the return generating process. But we should not sensibly

expect that inflation would have had a significant impact on farming returns during the 1960's. Availability of more frequent time series data would reduce the potential problem of structural changes.

ii) Recent research (Newman, Saunders, Pittaway and Gow (1990)) has suggested that investment in agriculture cannot be assumed homogeneous to other assets in the economy, including financial assets. Investment in farming may not be singularly motivated by economic objectives. Thus the risks associated with farm assets, and the return required from them is likely to be dependent on a number of non-systematic factors, which are not included in the set of economic factors used in this analysis.

5.0 Summary and Conclusions

The policy implications arising from this study depend on how we interpret the empirical results. On one hand, we could say that as none of the estimated coefficients are statistically significant, the APT model is inappropriate in explaining agricultural risk. Alternatively, we could say that if we accept the basic assumptions of the APT model, then the model suggests that in the context of a well diversified portfolio, agriculture is riskless and policies designed to reduce agricultural risk - by reducing the required rate of return - are of no use. The following section examines these two alternative interpretations in more detail.

5.1 If The Model Is Inappropriate.

The central assumption of the APT model is that investors can potentially hold well diversified portfolios derived from large competitive capital markets. However, problems occur in small markets such as New Zealand where the full benefits of diversification may not be realised due to the markets lacking depth or liquidity. In such a case, off-farm investors may be unable to hold a well diversified portfolio. Furthermore, the study by Newman *et al* also suggests that full time farmers may not be motivated solely by economic motives when they buy farms. Therefore it may not be appropriate to measure the risk associated with farming using any model derived from portfolio theory.

The eight time series of realised returns to equity are presented in appendix 1. The estimated returns indicate there have been large fluctuations for all eight farm classes throughout the period covered by this study. None of the time series appears to be closely correlated to the time series of risk-free returns, which suggests that the historical returns to equity differ substantially from the return we should expect from a risk free investment. However, the returns to equity have been estimated by adding the annual change in asset values to the farm cash surplus and dividing this aggregate return by the value of equity at the start of each year. These calculated values therefore represent a short-term return to equity, and their observed difference to the risk-free return time series does not invalidate the assertion that farming adds no risk to a diversified portfolio of assets. The realised long-term return on equity may more closely equate to the long-term risk-free return.

5.2 If The Model Is Appropriate

One of the major advantages of the APT is that the assumptions underlying the model are far less restrictive than those upon which the CAPM is based. In fact the most important assumption underpinning the APT model is that capital markets are informationally efficient or perfectly competitive. This assumption is based on the notion that in a perfectly competitive market investors can hold a well diversified portfolio. Therefore all assets will be valued on the basis of their systematic risk because all unsystematic risk may be freely diversified away and the arbitrage conditions of the APT model will hold.

It seems then that APT is an appropriate model as long as there are investors in the farm asset who are able potentially to hold well diversified portfolios of assets, and are only concerned with non-diversifiable, or systematic, risk. For most farmers, farming assets are predominantly their biggest single asset (Newman *et al*). However, although full time farmers own most of the available farm land, it can be argued that non-farming investors are the people who set farm prices at the margin, and that, not only do non-farming investors set land prices at the margin, but they also establish required rates of return at the margin. Non farming investors, such as urban or overseas investors, are more likely to hold agricultural assets along with other assets such as shares, commercial property and fixed interest investments. Therefore although the majority of investors in the farm do not hold a well diversified portfolio, it is potentially possible to do so. As it is possible to hold a well diversified portfolio arbitrage is also possible between underpriced and overpriced portfolios that have the same degree of risk. Therefore to the extent that non-farm investors' portfolios are well diversified, the APT model is appropriate.

If we accept that the APT model is valid then how do we interpret the outcome of the investigation? Simply, if the factors have coefficients which are not significantly different from zero, it implies that any risk is attributed to unique factors - as opposed to common factors. As we have assumed that the farm assets can be held in well diversified portfolios the impact of these unique factors can be diversified away. Therefore the only possible assumption we can draw is that an investment in meat and wool farming would contribute little or no risk to a well diversified portfolio. This point needs to be emphasised. We are not saying that agricultural assets - in isolation - have no diversifiable risk. Rather, we are merely saying that if agricultural assets are held in a well diversified portfolio they have no systematic risk and therefore if a farm asset is added to a portfolio of other assets, it will reduce the risk of the otherwise risky portfolio.

The policy implications that arise from such a conclusion are relatively simple. If an investment in farming adds no risk to a portfolio of assets, any policy instituted by the Government to reduce the risk of farming will have no effect on the required rate of return to the farm asset. The policy initiative may well influence the cash flows to individual farmers but it will do nothing to affect the rate of return required on farming assets (which we suggest approximates the risk free rate). From a portfolio theory point of view, where systematic risk is taken as the appropriate measure of risk, the potential reduction in risk which is unique to farming is irrelevant. All of this unsystematic risk can be diversified away by holding a well diversified portfolio of assets, and thus a policy initiative will not affect the required rate of return on an investment in the farm asset, although it could result in a change in the level of cash flows. In other words, if we assume that the value of the farm asset is the present value of a stream of cash flows then the results of this study imply that any risk reduction policy can only act on the cash flows. The policy should have no impact on the discount rate which is used to compute the present value, i.e., the required rate of return.

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APPENDICES

APPENDIX 1: Data Used for Time Series Estimation (Equation 7)

Table A1.

Year	Risk-Free	GDP(t)	CPI(t)	RP(t)	TS(t)
1961	0.0503	0.0210	-0.0001	0.0025	0.0054
1962	0.0475	-0.0367	0.0231	0.0031	0.0020
1963	0.0462	-0.0026	-0.0237	0.0039	0.0042
1964	0.0409	0.0289	0.0221	0.0059	0.0045
1965	0.0433	0.0002	-0.0010	0.0054	0.0104
1966	0.0484	-0.0002	0.0094	0.0045	0.0095
1967	0.0504	-0.0219	0.0183	0.0054	0.0068
1968	0.0489	-0.0458	-0.0223	0.0054	0.0049
1969	0.0488	0.0297	0.0168	0.0058	0.0066
1970	0.0460	0.0282	-0.0028	0.0067	0.0062
1971	0.0515	-0.0129	0.0549	0.0062	0.0091
1972	0.0504	-0.0113	-0.0325	0.0073	0.0037
1973	0.0439	0.0183	0.0018	0.008	0.0062
1974	0.0421	0.0260	0.0267	0.0038	0.0175
1975	0.0420	-0.0298	0.0427	0.0047	0.0190
1976	0.0549	-0.0228	0.0324	-0.0169	0.0440
1977	0.0575	-0.0153	-0.0355	0.0016	0.0304
1978	0.0881	-0.0291	-0.0214	0.0019	0.0424
1979	0.1050	0.0298	0.0038	-0.0175	0.0383
1980	0.1182	0.0231	0.0550	-0.0051	0.0299
1981	0.1118	-0.0145	-0.0299	0.0118	0.0108
1982	0.1202	0.0367	0.0203	0.0148	0.0181
1983	0.1307	-0.0437	-0.0870	0.0125	0.0157
1984	0.1088	0.0251	-0.0360	0.0342	-0.0301
1985	0.2000	0.0189	0.1194	0.0008	0.0645
1986	0.1735	-0.0366	-0.0623	0.0665	-0.0476
1987	0.1922	0.0144	0.0858	0.0928	-0.0124
1988	0.1586	-0.0202	-0.1258	0.0722	-0.0613
1989	0.1352	-0.0184	-0.0202	0.0519	-0.0275
1990	0.1382	0.0264	0.0323	0.0605	-0.0121

Table A2.

Year	ROE(*1*)	ROE(*2*)	ROE(*3*)	ROE(*4*)	ROE(*5*)	ROE(*6*)	ROE(*7*)	ROE(*8*)
1961	0.1909	0.0791	0.0302	0.0894	0.1242	0.1911	0.1866	0.1492
1962	0.1962	0.1342	-0.0796	-0.0704	-0.1064	0.1237	0.2270	0.1779
1963	0.1684	0.1953	0.1264	0.0053	0.1620	0.2190	0.2128	0.1795
1964	0.2003	0.1667	0.1506	0.3683	0.3768	0.1843	0.1965	0.1892
1965	0.1304	0.1898	0.1234	0.1638	0.1296	0.1381	0.1583	0.2619
1966	0.1595	0.1799	0.1331	0.1405	0.1228	0.1059	0.1310	0.1864
1967	0.1113	0.1879	0.0626	0.1461	0.0702	0.1320	0.1081	0.2202
1968	0.0969	0.1547	0.0909	0.1634	0.2081	0.1516	0.1133	0.1767
1969	0.1648	0.1836	0.1494	0.1671	0.1144	0.1678	0.1047	0.1727
1970	0.1793	0.1779	0.1693	0.1907	0.1222	0.0219	0.1732	0.0905
1971	0.2964	0.3791	0.2871	0.3218	0.2912	0.3117	0.3110	0.2949
1972	0.3033	0.3442	0.2840	0.3494	0.3160	0.2729	0.2773	0.2888
1973	0.3990	0.4214	0.3789	0.4466	0.4198	0.4058	0.3539	0.5427
1974	0.2211	0.2805	0.2373	0.2575	0.3011	0.4580	0.5852	0.5788
1975	-0.1780	-0.0363	-0.0938	-0.0472	0.0255	-0.0518	-0.0866	0.0775
1976	0.1916	0.1354	0.4981	0.3795	0.2720	0.2656	0.3440	0.2046
1977	0.3666	0.3209	0.2428	0.3860	0.2348	0.4116	0.5651	0.2386
1978	0.0356	0.1891	0.1046	0.1216	0.1314	0.1631	0.2020	0.0875
1979	0.3503	0.3250	0.7020	0.5639	0.4314	0.2760	0.4135	0.2303
1980	0.3574	0.3483	0.3540	0.4567	0.4051	0.4644	0.6811	0.3632
1981	0.4723	0.7098	0.3938	0.3575	0.2862	0.4530	0.1982	0.5018
1982	0.2506	0.0481	0.1254	0.1746	0.1019	0.1731	0.2248	0.3234
1983	-0.0146	-0.1009	-0.0071	-0.0267	0.0295	-0.1106	-0.1244	-0.1406
1984	0.1142	0.1776	0.0868	0.0708	0.0802	0.1177	0.1167	0.0375
1985	0.1829	-0.0674	-0.0519	-0.0411	-0.0531	-0.1625	-0.1338	-0.0700
1986	-0.2936	-0.3768	-0.2857	-0.3055	-0.2230	-0.3447	-0.3923	-0.6056
1987	0.4061	0.3998	0.0975	0.3012	0.2344	0.2870	0.4054	-0.0230
1988	0.3600	0.0305	-0.0482	0.0761	-0.0075	-0.0101	-0.0742	0.1967
1989	0.4307	0.2433	0.2060	0.3186	0.2985	0.1959	0.7230	0.9824
1990	0.0953	0.3843	0.3049	0.3580	0.3587	0.6398	0.6780	0.5837

APPENDIX 2: DEFINITION OF THE NZMWBES FARM CLASSES

CLASS 1. South Island High Country

Extensive run country at high altitude carrying fine wool sheep, located mainly in Marlborough, Canterbury and Otago.

CLASS 2. South Island Hill Country

Mainly fine wool sheep with a carrying capacity of around 3 s.u. per hectare. Mainly in Canterbury.

CLASS 3. North Island Hard Hill Country

Sheep and Cattle properties carrying around 8 s.u. per hectare. Mainly located on east and west coasts, and the central plateau of the North Island.

CLASS 4. North Island Hill Country

Located throughout the North Island, with a higher carrying capacity than class 3 farms.

CLASS 5. North Island Intensive Finishing Farms

Located mainly in South Auckland, Hawkes Bay, and the West Coast, these farms carry about 12 s.u. per hectare.

CLASS 6. South Island Finishing - Breeding Farms

Mainly in Canterbury and Otago, including some cash cropping.

CLASS 7. South Island Intensive Finishing Farms

High producing farms, mainly in Southland and South and West Otago, carrying around 13 s.u. per hectare.

CLASS 8. South Island Mixed Finishing Farms

Mainly in Canterbury, with high proportion of the revenue derived from grain and small seeds.

DIVERSIFYING RISK ON NEW ZEALAND SHEEP AND BEEF FARMS

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SUMMARY

Farmers now have greater responsibility for managing their own risk. This paper demonstrates that the Capital Asset Pricing Model is a powerful tool when it comes to choosing risk efficient diversified portfolios. By investing into non-agricultural related share market firms, New Zealand sheep and beef farmers can reduce exposure to a lot of risk factors.

BACKGROUND

The risks associated with farming in New Zealand have grown in the past decade. During the 1980s, farmers have seen major shifts in government policies and increased price variations for their produce. New Zealand farmers, especially those involved in wool, sheepmeat and beef production, are now more exposed to market forces than before.

It is important to evaluate agriculture's risk-return characteristics relative to those of other investments. First, there is an increasing interest in and policy concerns about agricultural investments by nonfarm investors, especially in farm real estate. Secondly, consideration by trust firms and other investment companies of mechanisms for channeling outside equity capital into agriculture is increasing. Thirdly, farmers are often being advised to diversify their asset base by investing in off-farm investments.

In this study, a single index model originally developed by Sharpe (1964) and Lintner (1965), and referred to as the Capital Asset Pricing Model (CAPM) is used to determine the proportion of non-diversifiable risk in the eight different farm types as classified by the New Zealand Meat and Wool Boards' Economic Service. On-farm as well as off-farm investment strategies for reducing exposure to risk are analysed, using this model.

This is the third in a series papers on the application of the single index model in the agricultural sector presented to this conference. The earlier papers, by Narayan and Martin (1990) and Narayan and Johnson (1991), looked at this model as a tool for selecting risk efficient enterprises within a farm. Unlike previous studies, this study looks at farm ownership as an investment portfolio and off-farm investment as a means of reducing exposure to risk.

The authors wish to acknowledge the contributions of the New Zealand Meat and Wool Boards' Economic Service and C S First Boston Pacific for providing all the data used in this study.

The views expressed in this paper are those of the authors and not necessarily the views of MAF Policy.

Although the CAPM is mainly used to determine risk adjusted investment opportunities, it is also a useful tool for determining the proportion of risk that can be ascribed to on-farm management as opposed to off-farm spreading of investment.

The CAPM expresses the expected return on an asset as a function of a risk free rate and a premium for risk.

$$E(R_i) = R_f + \beta_i [E(R_m) - R_f] \quad \text{Equation 1}$$

where $E(R_i)$ = expected return on an asset;
R_f = return on a risk free asset, such as 90 day Bank Bill rates;
$E(R_m)$ = expected return on the market portfolio; and
β_i = the relative risk of the asset.

$E(R_i)$ in equation 1 represents the risk adjusted discount rate for an asset. Beta (β_i) coefficient measures the expected responsiveness of asset i's returns (R_i) to changes in returns on a market portfolio (R_m) free of any diversifiable risk. Beta is a relative measure of risk, so the beta of the market portfolio is one. The beta of riskless government debt is obviously zero. A market portfolio could be the single most important factor influencing the returns (R_i), and is assumed to be fully diversified.

The beta coefficient gives an indication of the riskiness associated with an asset relative to the market portfolio. For example, a beta coefficient of 2.0 for an asset would indicate that the asset was twice as risky as the market portfolio, whereas a beta coefficient of 0.5 would signal that the asset was half as risky as the market portfolio.

In the absence of data on expectations, CAPM relationships usually are estimated by regressing a time series of returns for individuals assets against a time series of returns for a market portfolio (Barry, 1980):

$$R_{it} = \alpha_i + \beta_i R_{mt} + e_{it} \quad \text{Equation 2}$$

where R_{it} and R_{mt} are the rates of return on asset i and the market portfolio, respectively, in period t, and e_{it} is the error term.

The intercept term in equation 2, α_i, measures the expected return on an asset i when the return on the market portfolio is zero, and represents the average value over time of the diversifiable returns of the asset (Dobbins and Witt, 1983).

The CAPM equation for partitioning total risk into diversifiable and non-diversifiable components, is shown by equation 3, below.

$$\sigma_i^2 = \beta_i^2 \sigma_m^2 + \sigma_{ei}^2 \quad \text{Equation 3}$$

where, σ_i^2 = variance of returns from asset i;
σ_m^2 = variance of returns from the market portfolio; and
σ_{ei}^2 = variance of the regression residuals

$\beta_i^2 \sigma_m^2$ represents the non-diversifiable component while σ_{ei}^2 represents the diversifiable component of asset i's total risk. The diversifiable risk is that component of total risk which is unique to an investment, whereas the non-diversifiable component is that which is common with the market portfolio ie they are market portfolio related risks. The latter type of risk are the effect of changes in general economic activity and will affect all investments alike. To reduce a portfolios risk, the investor must put together investments whose returns do not follow similar patterns ie investments whose returns are not highly correlated.

Provided all the required data is available, the CAPM is relatively simple to use. However, skeptics are concerned about the model's restrictive assumptions. The model assumes that the markets are highly efficient so that expected returns quickly and fully reflect available information; no transaction costs, and tax obligations exist; and, for risk-free financial assets, lending and borrowing rates are equal. Investors are assumed to be risk-averse, well diversified and to hold homogeneous expectations that are fully characterised by means and variances over single period horizons (Barry, 1980).

PREVIOUS AGRICULTURAL APPLICATIONS OF THE CAPM

Amongst the earlier reported studies on the application of CAPM to agriculture include that of Collins and Barry (1986), and Turvey and Driver (1987). The former is an American study, while the latter is Canadian. A more recent American study is that by Amegbeto and Featherstone (1992). Narayan (1990), Narayan and Martin (1990) and Narayan and Johnson (1991) look at the application of the model in the New Zealand setting. Clarke et al (1992) did a similar study in Australia. These studies looked at how CAPM could be used to select enterprises within a given farm.

Barry (1980) was the first to use CAPM in an agricultural investment framework. Barry estimated risk premiums required to hold farm real estate in a well-diversified market portfolio that also included non-agricultural assets. Moss et al (1991) and Bjornson and Innes (1992) have recently turned to this type of application for CAPM.

Bell (1991), in his survey of the application of CAPM in New Zealand agribusiness reported that large internationally trading corporates are rigorous in their application of CAPM. Although Bell reported that the agribusiness sector has addressed this recently, he did not mention any agribusiness firm that was using the model in their investment decision making process. Bell noted that the required data for using CAPM was very thin in New Zealand, and that betas were derived from large offshore markets with consideration of local special factors.

DATA

Three sets of data are required: the historic rates of return for each investment, the rate of return for a risk free asset, and the historic rate of return for a market portfolio, appropriately risk diversified.

1 Return on individual assets.

Nine year (1980/81 to 1988/89, June Year) historic time series data for six individual Meat and Wool Boards' Economic Service farms in each of the eight farm classes are used. Each farm class is the average of six farms.

2 Return on a risk-free asset.

A good approximation will be the rate of return obtainable on long-term freely-traded government guaranteed securities. Although yield on five year government stock can be utilised as a proxy for the risk free rate, the current 90 day Bank Bill rate is preferred as it eliminates inflation uncertainty.

3 Return on a Market Portfolio (or Market Index).

Defining a true market index is difficult. It has to be well diversified. This is more difficult for agricultural assets, especially in New Zealand. However, the following were analysed as proxies for the market index that could be suitable for analysing agricultural assets.

(a) All farm class (NZMWBES) weighted average of net return on farm capital.

This is a weighted average of net returns of all the eight Meat and Wool Boards' Economic Service farm classes, reflecting a correct degree of importance of each farm class in the New Zealand sheep and beef industry. This index can be used to compare return on investments from one sheep and beef farm type with another, but cannot compare a farming asset with a non-farm asset.

(b) New Zealand Stock Exchange All Ordinaries Gross Index

This is a gross index, and incorporates all registered assets in the New Zealand share market including all the registered agricultural related assets. This therefore may be a useful index for comparing both one farm class with another and for comparing a farming with a non-farming asset. Data on this index was supplied by C S First Boston Pacific.

(c) New Zealand Stock Exchange Composite Agricultural Index

Although not many, there have been some agricultural sector related assets registered on the New Zealand share market over the last decade. These include corporate firms involved mainly in farming and processing farm products such as meat works. All such assets have been put together to form a composite market index for the agricultural industry. Data on this index was supplied by C S First Boston Pacific.

SHEEP AND BEEF FARM CLASSES[1]

Farm Class 1 : High Country, South Island. Extensive run country located at high altitude carrying fine wool sheep, with wool as the main source of income. In Canterbury, Otago and Marlborough.

Farm Class 2 : Hill Country, South Island. Mainly fine wool sheep and with a carrying capacity of around three stock units per hectare. Wool and sales of cast-for-age ewes are a major source of income. Mainly in Canterbury.

Farm Class 3 : Hard Hill Country, North Island. Carrying around nine stock units per hectare with twelve sheep per cattle beast. Sheep provide approximately three quarters of the revenue, the balance being derived from the sale of cattle. Mainly on east and west coasts and central plateau of North Island.

Farm Class 4 : Hill Country, North Island. Easier hill country and smaller holdings than class 3. Mainly Romney sheep and carrying over ten stock units per hectare with thirteen sheep per cattle beast. A high proportion of sale stock sold is in forward store or prime condition. These farms are throughout the North Island.

Farm Class 5 : Intensive Finishing Farms, North Island. High producing grassland farms carrying twelve stock units per hectare with ten sheep per cattle beast. Replacement ewes often bought in. Mainly located in South Auckland, West Coast North Island and Hawkes Bay.

Farm Class 6 : Finishing-Breeding Farms, South Island. A more extensive type of finishing farm generally breeding own replacements and frequently with some cash cropping. Mainly in Canterbury and Otago.

Farm Class 7 : Intensive Finishing Farms, South Island. High producing grassland farms carrying about thirteen stock units per hectare and with some cash crop. Mainly in Southland and South and West Otago.

Farm Class 8 : Mixed Cropping and Finishing Farms, South Island. Mainly in Canterbury, with a high proportion of the income being derived from grain and small seeds as well as finishing stock.

[1] *Sheep and beef farms as classified by the New Zealand Meat and Wool Boards' Economic Service.*

RESULTS AND DISCUSSION

The results in Table 1 indicate that there is not a very large difference in the riskiness of the various Meat and Wool Boards' Economic Service farm classes. Farms having higher risk coefficients include farm classes 2 (beta = 1.17), 7 (beta = 1.19) and 8 (beta = 1.15), and those with lower risk coefficients include farm classes 3 (beta = 0.85), 4 (beta = 0.90), and 5 (beta = 0.88). The beta coefficient for farm class 6 is not statistically significant. A high beta coefficient indicates more variation in returns than the all class average farm, and vice versa.

Table 1: Beta Coefficients and Expected Returns for the Different Sheep and Beef Farm Classes, Market Portfolio (Rm) = All Class Average Farm[1]

Economic Service Farm Classes	Beta	R Squared	Alpha	Historic Rate of Return	Total Risk[2]	% Non-Diversifiable Risk[3]
	β_i	R^2	α_i	R_i (%)	σ_i^2	(%)
1 SI High Country	1.05*	0.72	7.02*	11.1	313	88
2 SI Hill Country	1.17*	0.70	-2.80	1.8	379	90
3 NI Hard Hill Country	0.85*	0.79	0.93	4.2	183	98
4 NI Hill Country	0.90*	0.72	1.15	4.7	208	97
5 NI Intensive Finishing	0.88*	0.66	0.32	3.7	204	94
6 SI Finishing-Breeding	0.53	0.50	0.29	2.4	188	37
7 SI Intensive-Finishing	1.19*	0.88	-1.09	3.5	375	94
8 SI Mixed Cropping	1.15*	0.77	-2.91	1.6	377	88

* Denotes statistical significance at the 0.20 level of confidence.

1 The results presented in the table are average for 6 farms in each farm class.
2 As measured by the variance of farm returns.
3 See equation 3.

With the exception of farm class 6 (SI Finishing-Breeding), the proportion of non-diversifiable risk in each farm class, using equation 3, shows that between 88 and 98 percent of the total risk is non-diversifiable. This suggests that if a sheep and beef farmer wishes to reduce his exposure to risk he should not look to other sheep and beef farm activities but look at off-farm assets.

Because the analysis in Table 1 uses an all class average sheep and beef farm as the market portfolio, the non-diversifiable risk component includes those factors that are common to all the sheep and beef farm classes. All the factors common to sheep and beef farms are unlikely to affect non-farm investments. Thus, these results will be of little use to an investor who wishes to compare investments in sheep and beef farms with off-farm investments.

To analyse a wider investment portfolio, such as a portfolio mix of investments in a farm and in an equity market, the market portfolio need to be changed to a much wider portfolio that would include all these different types of investments. One such market portfolio is the New Zealand Stock Exchange All Ordinaries Gross Index.

When NZSE All Ordinaries Gross Index is used as a market portfolio, the R Squared is between zero and 0.2, as shown in Table 2. This means that when the returns from these farm investments are plotted in a graph, with annual farm returns (Rj) on the Y-axis and the return on the market portfolio (Rm) on the X-axis, it is virtually impossible to draw a regression line. However, if a regression line is forced, it gives a negative slope, as shown by the negative beta coefficients in Table 2. Although these beta coefficients are statistically not significant, one possible explanation for the negative slope is that during the period under analysis (1980 to 1989), changing government policies, such as removal of farm subsidies and other de-regulatory policies, may have affected the farming sector more than the equity market, and hence farm returns moved contrary to equity returns. This is not expected to continue, and therefore the negative beta cofficients are not expected arise in future.

Table 2: Beta Coefficients and Expected Returns for the Different Sheep and Beef Farm Classes, Market Portfolio (Rm) = NZ Stock Exchange All Ordinaries Gross Index[1]

Economic Service Farm Classes	Beta	R Squared	Alpha	Historic Rate of Return	Total Risk[2]	% Non-Diversifiable Risk[3]
	β_i	R^2	α_i	R_i (%)	σ_i^2	(%)
1 SI High Country	-0.23	0.20	17.57*	11.1	313	20
2 SI Hill Country	-0.11	0.04	4.90*	1.8	379	4
3 NI Hard Hill Country	-0.11	0.07	7.24*	4.2	183	8
4 NI Hill Country	-0.09	0.07	7.24*	4.7	208	5
5 NI Intensive Finishing	-0.10	0.05	6.52*	3.7	204	6
6 SI Finishing-Breeding	0.11	0.05	-0.62	2.4	188	8
7 SI Intensive-Finishing	-0.15	0.07	7.69*	3.5	375	7
8 SI Mixed Cropping	-0.18	0.10	6.74*	1.6	377	10
All Class Average Farm	-0.19	0.10	15.80*	3.9	249	17

* Denotes statistical significance at the 0.20 level of confidence.

1 The results presented in the table are average for 6 farms in each farm class.
2 As measured by the variance of farm returns.
3 See equation 3.

The extremely low R Squared with NZSE All Ordinaries Gross Index supports the conclusion that the proportion of non-diversifiable risk is very low, or below 10 percent for most of the farm classes. This clearly suggests that the sheep and beef farmers can eliminate nearly all the risk exposure by diversifying their investments into equity (or off-farm) markets. The reverse should also hold, that investors in the equity market can eliminate lot of their exposure to risk by investing in sheep and beef farms. The returns from farms have very low correlations with returns on share market.

Anecdotal evidence suggests that those farmers who in recent years have invested off-farm, have mainly invested in firms registered in stock markets that are involved in processing farm products or are supplying inputs to farms. Farmers have generally preferred to invest in industries they are more familiar with.

However, the results in Table 3 suggest that by investing in non-farm but agricultural sector related investments farmers will not be able to reduce much of the non-diversifiable risks they are exposed to. When New Zealand Stock Exchange Composite Agricultural Index is used as the market portfolio, between 20 and 70 percent, or an average of 37 percent, of the non-diversifiable risks remain. However, when the NZSE All Ordinaries Gross Index was used as the market portfolio, as in Table 2, the average non-diversifiable risk for all the farm classes was 8.5 percent. There is some correlation between returns from farm investments and returns from non-farm but agricultural related investments.

Table 3: Beta Coefficients and Expected Returns for the Different Sheep and Beef Farm Classes, Market Portfolio (Rm) = NZ Stock Exchange Composite Agricultural Index[1]

Economic Service Farm Classes	Beta	R Squared	Alpha	Historic Rate of Return	Total Risk[2]	% Non-Diversifiable Risk[3]
	β_i	R^2	α_i	R_i (%)	σ_i^2	(%)
1 SI High Country	0.35	0.17	6.97*	11.1	313	18
2 SI Hill Country	0.58*	0.35	-4.96	1.8	379	41
3 NI Hard Hill Country	0.38	0.33	-0.29	4.2	183	37
4 NI Hill Country	0.41	0.29	-0.16	4.7	208	38
5 NI Intensive Finishing	0.42	0.30	-1.17	3.7	204	40
6 SI Finishing-Breeding	0.53*	0.38	-3.79	2.4	188	70
7 SI Intensive-Finishing	0.38	0.19	-0.95	3.5	375	18
8 SI Mixed Cropping	0.55*	0.37	-4.84*	1.6	377	37
All Class Average Farm	0.54*	0.30	4.05*	3.9	249	54

* Denotes statistical significance at the 0.20 level of confidence.

1 The results presented in the table are average for 6 farms in each farm class.
2 As measured by the variance of farm returns.
3 See equation 3.

CONCLUSIONS

This study has demonstrated that the Capital Asset Pricing Model is a useful tool for investors, both farmers and non-farmers, to choose portfolio diversification options.

From the results of this study, it can be concluded that for farmers to reduce their exposure to risk, they must diversify their asset base by investing off-farm. Although a lot of risk can be eliminated by investing in agricultural related stock market firms, investments into non-agricultural related share market firms would eliminate most of the exposure to risk the farmers currently face.

The eight farm classes studied showed common characteristics both within farming and in comparison with composite agricultural share index. They can thus be regarded as a risk-similar group; with common non-diversifiable risk patterns, and common opportunities to reduce risk by investing off-farm.

The quantitative reduction of risk by moving from farm to a mixture of farm and non-farm assets has not been estimated but could be a useful exercise to follow up.

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FINANCIAL RATIO ANALYSES AS MEASURES OF SHEEP AND BEEF FARM PERFORMANCE

By
G. Frengley and C. Uriarte

The analysis of financial statements is widely used to assist with management decisions. Information presented in general purpose financial statements, can be particularly useful in making economic decisions and other evaluations about the reporting entity. Supporting calculations and interpretation of financial ratios show relationships that exist between various items. It was not intended to make this paper into an extensive study of accounts interpretation, its objective is to introduce readers to the easy way in which a considerable amount of information can be gained from financial accounts using ratio analysis. The use to which this information is then put may be more important than the data itself.

The paper emphasizes the role of financial analysis in the evaluation of farm performance as the information obtained is an indispensable aid for most lending, investing, and other related decisions. First, the advantages and limitations of farm financial statements (often referred to as farm accounts) are discussed. In the second and third parts of this paper, the discussion is focused on the use of financial analysis using ratio analyses as measures of farm performance. And finally, the relevance of the ratios, standards adopted in financial comparisons, and some benchmarks of financial ratios for New Zealand sheep and beef farms, are given.

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FINANCIAL RATIO ANALYSES AS MEASURES OF SHEEP AND BEEF FARM PERFORMANCE

By
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18/8/92

I.- ANALYSING FARM PERFORMANCE THROUGH FINANCIAL STATEMENTS:

Analysing a set of financial statements, involves using ratios of key financial variables and other analytical tools, to gain insight into the operating performance and financial health (vulnerability to risk) of a farm. With the availability of computerized data bases and financial analysis packages, much of the analytical work is done "on line". The real challenge to the analyst is the interpretation of the results. Such interpretation requires that:

(1) The purpose of the analysis be clearly specified.
(2) The important concepts and principles underlying the financial statements on which the ratios are based, be understood.
(3) The economics and current conditions facing the business, be factored into the interpretations.

Objectives of a Financial analysis:

The main object in the analysis of business accounts, is to be able to reach some assessment of the worth of the farm, and the efficiency with which its management uses the firm's assets in order to achieve the farm family's goals. However, the accounts analyst will not always have the same point of view towards his study: "the emphases which he portrays will depend upon the reasons for the analysis "(Rockley: 1984). Much of the variation in the method of analysis of farm performance, arises because the study is being prepared for different purposes or different end users. Accordingly, like many farmers, most farm consultants have developed their own methods of financial analysis.

Among the most common end users are: farmer clients, financiers, investors and industry groups. The objectives in the case of farmer clients should include identification of strengths and weaknesses in the farming operation; setting of realistic financial targets based on similar properties; the provision of a financial record of standards and benchmarks for comparison; and the identification of changes in the overall position. The analytical methods used to achieve these objectives must be "digestible" and easily read. The analysis should include financial comparisons of farms and between trends within farms. These are frequently sought for farmer clients. Graphic representation of results is often desirable, but ultimately to effect change, individual enterprise analysis is needed.

Financiers are more concerned with profitability and security on a forward planning basis. The financial structure of the farm is of interest to creditors, because the amount of equity capital in relation to debt, is an indication of the risk that the owners bear in relation to the creditors. Equity capital is important as it provides creditors with a cushion against loss. In contrast, an investor in a farming operation is most interested in classic investment criteria such as return on capital employed, the variability of that return and the management and cost inputs required to achieve that return.

Clear examples of industry groups in New Zealand are : New Zealand Meat and Wool Board Economic Service, and Ministry of Agriculture and Fisheries Farm Monitoring reports. Standardization in method among these groups is highly desirable. Analysts interpreting data from these groups should make themselves aware of the definition used. Usually industry compilers are more interested in historical data and in gross performance parameters than in the performance of different enterprises within one farming type.

In this paper, we will be concerned with the farmer client as the end user, and discuss the relationship to other similar users. According to the needs of these possible end users, Stickney (1990) suggests that the most common reasons for a financial analysis are: equity investment, credit extension, internal operation analysis and/or going concern judgement by auditors. Among the most frequently encountered reason for analysing financial statements, is to aid the decisions to acquire, retain or sell an equity or ownership interest in the farm. The farmer is usually interested in the expected return from the investment relative to the risks involved. Supporting data required for credit extension will frequently include equity and trend analyses demonstrating the ongoing viability of the enterprise. On the other hand a farmer may wish to analyse the operating performance of its business, as a basis for performance evaluation, planning and budgeting, or an alteration of strategies. Finally, the independent accounter, in expressing an opinion on a client's financial statements, must make a judgement as to whether the farm is a going concern (financially viable). The accounting process would asses the profitability, financial condition, and cash-generating ability of the enterprise in making judgement.

Limitations of Accounting Data :

As Popoff and Cowan (1985) stated, the financial statements as such, contain very little information about the character, motivation, experience, or age of the human resources. Nor do they contain information about the quality of the research and development effort, or the breadth of the marketing organization. The simplification in the accounting framework is

necessary in order to classify the great variety of economic events into a manageable number of categories. Inevitably, this simplification can be achieved only at the expense of clarity and detail, which in some instances could have been useful to the user of financial data. Financial statements may not be of uniform quality and reliability, because of differences in the character and the quality of judgements exercised by accountants in their preparation. To be useful, accounting information must be timely. To do it may require some estimation, and the greater the degree of such estimation required, the greater the amount of uncertainty that is inevitably introduced into the financial statements. They also do not, in most cases, represent current market values. The analyst must be aware of valuation bases other than historic cost that are used in financial statements. Over the years the value of money has undergone significant fluctuations in purchasing power, and generally has a pronounced downward trend due to the erosive effects of inflation. This must be considered in the conclusions. And finally farmers and accountants, classify items in their financial statements in different ways. Any ratios involving these differences will not be comparable across the farms involved. The goal when comparing two or more farms is to obtain comparable data sets. A scan of the financial statements should permit the analyst to identify significant differences that might affect the analysis and interpretations.

Stickney (1990) suggests that an effective analysis of a set of financial statements, requires an understanding of the economics and current conditions of the business in which a farm is involved; the particular strategies a firm has selected to compete in the business; and the accounting principles and procedures underlying the financial statements. Equipped with these three essential buildings blocks, the analyst can asses the success of the strategies relative to the level of risk incurred.

Using Financial Ratios to Measure Farm Financial Performance :

Many authors such as Adelaja and Rose (1988); Gibson (1989); Miller and LaDue (1989) and Mortensen et al. (1988), have developed alternative approaches to the use of financial ratios to evaluate farm financial performance, when suitable data is available. Financial analysis can help detect emerging problems and strengths in a firm. Used in conjunction with the budgeting process, the analysis can be particularly helpful. Farms managers must analyse the data from the view-point of both investors and creditors. They must be concerned about the current position of the entity and its ability to meet its obligations, as well as the future prospects of the farm. They should also be interested in the financial structure of the entity in order to determine a proper mix of short-term debt, long-term debt, and equity from the owners' viewpoint. The asset structure of the entity, that is, the combination of cash, inventory, receivables, investments, and fixed assets, is also of interest. It does the entity little good to be guided toward a maximum profitability goal, if resources are not made available to meet current obligations. Liquidity and profitability are competitive since the assets that are most highly liquid, are commonly the least profitable. Hence, it is necessary for managers to guide the farm toward sound short and long term financial policies and, at the same time, earn a profit. The literature cited above agree that farm managers should used multiple criteria (examination of a set of financial ratios), to examine farm financial viability. Conclusions obtained using single financial ratios may be mistaken.

II.- RATIO ANALYSIS :

Physical and financial ratios have been used by managers for a long time. Foulke (1968) mentions them being used in "the last few years of the nineteenth century". And for those interested in the history of the use of financial ratios, J. O. Horrigan's " A Short History of Financial Ratio Analysis" (The Accounting Review, April 1968), is a good reference. No figure is meaningful in isolation. To have meaning, figures must be compared consciously or subconsciously with another figure. As Westwick (1987) says " a ratio express the mathematical relationship between one quantity and another", and it can be expressed as a percent or a proportion (number). Ratios are among the best known and most widely used tools of financial analysis. At the same time, their function is often misunderstood, and subsequently their significance may easily be overrated (Bernstein: 1989). Ratios are useful to measure the progress of a business and to compare with others which are similar. They can help to point out areas that need more investigating or assist in developing a future operating strategy. But, as Gill (1990) suggests, they cannot take the place of experience or replace good management; they will make good managers better.

Ratios should supplement, not supplant financial data. The analysis of farm accounts using ratios can disclose relationships, as well as bases of comparison, that reveal conditions and trends that cannot be detected by an inspection of the individual components of the ratio. It is, for example, of little value to look at an item of expenditure in isolation. It is important to know why this expenditure is being incurred, what benefits it is hoped to gain from it, and whether the benefits can be measured and quantified. A measure of the effectiveness of the expenditure is then the ratio of the measured benefits to the expenditure. Since ratios, like other tools for analysis, are future oriented, the analyst must be able to adjust the factors present in a relationship to their probable shape and size in the future. Thus, in the final analysis, the usefulness of ratios is wholly dependent on their intelligent and skilful interpretation. This is by far, the most difficult aspect of ratio analysis.

Ratio selection :

Given the large quantity of variables included in financial statements, a very long list of meaningful ratios can be derived. There is no standard list of ratios or standard computation of such, and each author reporting on financial statement analysis uses a different list. In order to analyse the resultant changes in financial performance, a compromise is required between the availability of statistically reliable information, and the appropriateness of each financial performance measure. The suitability of each measure, is dependent on its ability to correctly relate its estimated change to the underlying cause. Furthermore, as Johnston and Frengley (1990) state " their use is dependent on the purpose of the analysis, whether to provide an interpretive view of historic events or to promote correct decisions at any time, to improve expected financial outcomes".

Before any ratios can be selected, the farm family's objectives or goals must be clearly defined, and these goals must be ranked in some order of relative importance. This order is likely to change over the course of time. As one objective is achieved, another becomes more important. Priorities will also change in response to changes in outside pressures. According to Gibson (1989), to determine which ratio to use the analyst must first consider: the global economy (referring here to the farm business environment); for instance some farms might require a large number of fixed assets, buildings, land, equipment, tools, etc. while another requires very few; the age of the business, if the business has passed the initial three to five

years start-up period and has liquidity, the interest is probably in expansion (in this case, the profitability and efficiency ratios will be factors to be closely monitored); the point in the business cycle or whether the business is just getting started, is achieving growth, or has reached maturity; and the objective of the analysis.

Ten basic principles of ratio selection :

Selecting ratios is an exercise which must be done individually for each farm and manager. Each manager from time to time should review the ratios he uses, and be aware that there is an insidious tendency for the amount of information that is provided to grow. Westwick (1987) suggests ten basic principles for ratio selection:

1. If possible, a manager must be provided with a single key ratio that indicates unequivocally the degree of his success, together with subsidiary ratios explaining how this success can be improved.
2. Ratios should be logically interrelated.
3. Pseudo ratios must be avoided.
4. A manager must not be given ratios which cannot lead to action by him.
5. A ratio must measure a material factor of business, not a trivial one.
6. The ratio of the cost of obtaining the information, to the likely benefit to management of having it, must always be borne in mind.
7. The number of ratios provided to any one manager, must be kept to the minimum.
8. Different ratios are required for different farms.
9. Within a firm, different levels of management require different ratios.
10. A manager's need for specific ratios changes as his problems change.

Limitations to the use of ratios:

Despite the fact that ratio analysis is a useful tool, financial analysis or traditional ratio analysis operates under a number of constraints. For example, ratio analysis is viewed as an empiricist practice, because financial ratios will reflect the limitations of the data on which they are based and are often inadequate to capture the complex relationships which exist within the business situation (Popoff and Cowan: 1985). Furthermore, ratio analysis has been criticized for not including any other information as expressed in certainty terms.

Recent studies have pointed out that, to overcome those constraints, formal decision models can be applied. For example Fuzzy Set theory can be applied to ratio analysis with respect to one of the major management problems: liquidity . This approach makes it possible for decision makers to apply their own experiences and any other type of information to that obtained by the ratio. If all the possible decisions are uniform in time, they could be adopted by the decision maker in a programmed form through a simple input combination in each time period of the analysis (Gutierrez and Carmona: 1988).

III.- SUGGESTED FINANCIAL RATIOS TO ANALYSE FARM PERFORMANCE :

Many types of criteria can be used to indicate the financial progress of a business. In general, however, most of the authors that have written about financial management (for instance Gibson: 1989; Gill: 1990; Hopkin et al: 1973; Madura and Veit: 1988; Penson & Lins: 1980; Rockley: 1984; Schall and Haley: 1986, and many others), agree in classifying four important facets of a firm's business and financial "health" about which managers will want to keep informed: liquidity, solvency, profitability and efficiency. This paper will include a fifth one suggested by Johnston and Frengley (1990), the financial stress ratio.

Liquidity ratios :

" Liquidity refers to the anticipated ability of the business, to have sufficient cash available to meet financial commitments as they become due, without disrupting the ongoing operation of the business" (Sidney and Everett: 1986). Liquidity ratios may include measures used to determine efficiency:

* **The Current Ratio** is the first of these. (It is also called the Working Capital ratio (Rockley: 1984). The current ratio is the most frequently used measure of liquidity. It measures the firm's ability to meet short term obligations and is obtained by dividing current assets by current liabilities, (Gill (1990) also refers to Working Capital as the difference between current assets and current liabilities). For Gill (1990) caution must be taken in its interpretation, because a farm operator may hold most current assets in cash or savings. The proper ratio depends on the type of business, the time in the business cycle, and the age of the business. Sidney and Everett (1986) suggest however that the safety in the use of this ratio is dictated somewhat by the amount of uncertainty associated with the income of the particular business; the greater the variability and uncertainty, the higher the ratio must be. Some farm lenders reject all loan applications where the current ratio is less than 1.0, but fortunately such rigid reliance on this ratio is not common.

* **The Debt Structure Ratio** is used less frequently than the current ratio in liquidity analysis, and is calculated by dividing current liabilities by total liabilities. In general, it is suggested that the lower the value of this ratio, the more liquid the farm operator is, but care must be taken in making such interpretations, particularly if contingent liabilities are included in the denominator. The optimal level of the debt structure ratio will likely vary by type of farm.

Solvency ratios :

Solvency ratios or borrowing capacity ratios, measure the degree of protection of long-term suppliers of funds. Their concern is with the spoils if all assets were liquidated (sold) and all debts and obligations paid.

* The **Leverage Ratios, (Debt to Equity Ratio or Debt to Total Asset Ratio)**, express the relationship between capital contributed by the creditors and that contributed by the owner(s), to finance the total business. It is given by dividing total debts by Equity (synonymous with Net Worth) or Total Assets. Lenders are particularly interested in this ratio since it is a good measure of the financial risk involved. Some analyst feel that current liabilities to net worth should not exceed 80%, and long-term debt should not exceed net worth by 50%. Some farm lenders set rigid guidelines, and do not grant loans to potential borrowers with a Debt/Equity ratio in excess of 2.0. But again, much depends on where, and what the business is about. In Current circumstance New Zealand Meat and Wool Board's Economic Service (NZMWBES) data suggests that on average, in recent years, sheep and beef farms whose debt to total asset ratio has exceeded 20 % have been unable to maintain profits.

* **The Net Capital Ratio,** calculated by dividing total assets by total liabilities, is tabulated for almost all major loans, whether used to finance fixed assets or current farm production. The lending institutions have been vocal in specifying their considered view of a safe ratio. The nature of the business being financed, dictates to a large degree the safety of the ratio required. Some farms have enterprises and activities that provide more stable and reliable income than others, and these are allowed higher ratios than farms with unstable income flows and less secure markets.

* The **Net Worth** (or Equity), is equal to the difference between Total Assets and Total Liabilities. The **Net Worth Ratio** is calculated by dividing the Net Worth by Total Assets. It is closely related to the debt/total asset or leverage ratio (Net Worth = 1 - Debt/T. assets), and has similar properties. An acceptable limit for the Net Worth or Equity ratio, for New Zealand sheep and beef farming in the 1970s was 50 %, in the early 1980s 80 % and now appears to be 50%.

* **Long-term Debt to Equity Ratio:** A low ratio provides greater protection to owners in the form of a larger equity cushions. It helps to identify the most suitable debt time-structure. As it relates to both the Leverage and the Net Worth ratios. Approximate limits for sheep and beef farms lie between 40 and 50 % nowadays.

* **Financial Leverage Index (ROE/ROA):** Ratios greater than one indicate that the return on equity is greater than the return on assets, indicating there is an economic advantage to be gained by further investment via debt, because capital costs are less than earnings. As it does not reflect the risk of debt if prices fall, it should be tempered with the Debt to Total Assets ratio.

* **Times interest Earned,** refers to the relationship between earnings before interest and taxes (EBIT), and total interest payments. It is obtained by dividing the EBIT by interest paid. The higher the ratio, the more easily can a firm cope with its debt obligation.

* **Interest as a % of Gross Farm Income,** high total interest costs crowd out opportunities for discretionary expenditure.

It is important to note when considering the liquidity and solvency ratios presented above, that the farm business must be clearly separated from other activities. Lenders are interested in the liquidity and solvency of individuals rather than of their farm business. It is quite conceivable, that an individual farm operator could have an illiquid farm business, but yet remain liquid as an individual because of his non-farm assets and non-farm income.

Profitability ratios:

Profitability ratios provide a means to measure the earning ability of a firm. As a general rule the principal objective of firms is to maximize profits. The objective of most businesses is to generate profits; commonly to maximise profits. Changes in the profitability ratios are induced by changes in prices, volume and costs. Therefore, changes in the ratios are affected by management adjustments altering price and/or volume.

* **Return on Capital**, refers to the return available to the owner-operator of a freehold, unencumbered farm, after allowance has been made for his labour and management input. The percentage measurement is given by dividing the economic farm surplus (EFS) by total farm capital, where EFS is the Net Farm Income plus managerial salary, plus interest and rent paid, minus the assessed managerial reward.

* **The Return on Assets (ROA)** is calculated by The Net Farm Income plus interest expense divided by total assets, and measures the firm's ability to utilize its assets to create profits. Assets are based on their current valuation. For farming operations, the rate of return on total assets is potentially misleading, for several important reasons. First, the nature of farming operations is such that it is often difficult to separate farm and non-farm assets and liabilities. Secondly, we have to assume an imputed rate of return to operator and unpaid family labour and management, which are often hard to determine and thus are frequently quite arbitrary. Finally, it should be recognized that this rate of return does not include unrealized capital gains associated with farm business assets. Despite these problems, however, this ratio is still an extremely important measure of the financial performance of the farm business. Problems will arise when making comparisons with any other farm business because of differences in the imputed value assigned to returns to the operator and unpaid family labour and management. Given a consistent set of assumptions, however, these ratios can provide the basis for useful analyses.

* **The Rate of return on equity capital (ROE)** describes the returns per dollar of the ow ner's invested capital, and provides a basis for comparison with rates of return on non-farm investments. It is calculated by dividing the Net Farm Income by the Net Worth. In practice, this rate of return may be difficult to apply in situations where farm business and farm household activities are co-mingled. As in the previous ratio, the value imputed for returns to operator and unpaid family labour and management will affect this ratio, as will the lack of recognition of unrealized capital gains.

In general, successful use of these profitability ratios can best be accomplished by using a consistent set of assumptions in measurement, and by being aware of the reasons behind potential differences, when comparing the outcome with that of similar operations.

Efficiency or Activity ratios:

These ratios measure the degree to which the farm manager uses the resources at his disposal, to achieve a desired result. Efficiency ratios are typically based upon the premise that the "desired" result is to obtain maximum output from a given set of inputs (Rockley:1984). They can take two general forms, since inputs and outputs can be measured in either physical units or dollar values:

a) In dollar values:

* **The Turnover ratio**, which measures the gross farm income generated per dollar of farm business assets the farm operator controls.It is obtained by dividing the Gross Farm Income by the Total Farm Business Assets owned and rented. An important point is that the same method of valuing farm assets must be used when making comparisons with other farm businesses.

* **Interest as a % of Total Farm Expenditure,** relates to firm efficiency in that higher proportions of interest expense crowd out expenditures on other productive inputs.

b) In physical units : Common examples are yields per hectare, kg of meat per kg of gain, milk production per cow, etc. While physical ratios or benchmarks are important measures used for comparison between farms and are commonly discussed by farmers they are not central to this study

It is important to recognize, however, that maximizing a physical efficiency ratio is not necessarily consistent with economic efficiency. Unless the production practice generates more profit than any other alternative practice, it is not economically efficient.

Financial Stress ratios :

As Frengley and Jonhston (1990; 1991) suggest, accounting financial ratios are not suitable measures to express some facets of financial stress affecting farm business and implicity farm families. Their failure stems from an inability to account for changes in marginal utility; nor do they account for the farm operator's expectations of future events. These are essential differences between purely financial measures and those which involve utility. Financial ratios are based upon averages while efficiency measures and economic effects are based upon marginal concepts and utility. As a consequence, while financial ratios adequately represent the effects of financial changes on the farm business, they may easily misrepresent the effect on the farm family. This an area that has not received adequate attention in the literature.

Accounting financial ratios help us to make decisions based on past experience after comparing our data (usually expressed in averages), with suitable standards of comparison. But they do not tell us anything about the decision maker's perceptions of the future alhthough this will most certainly affect his financial decisions. As Sidney and Everett (1986) state: " most business borrow with the expectation and hope that the net returns to the total investment, expressed as a percentage, are greater than the interest cost required to finance borrowed capital". It is common for optimistic and positive attitudes about the future of investments to follow successful outcomes: the inverse is also true.

The stress ratios account for these psychologically influenced behaviours. The reality of psychological effects should be considered when evaluating farm performance to better understand the context in which the farm operator has to make his financial decisions. Frengley and Johnston (1992) proposed **The Consumption Stress Ratio** as a better measure of financial stress affecting farm operators. It is given by dividing Net Interest payments by Net Household Consumption. Net household consumption is the sum withdrawn from current net farm income, but in the adjusted version of the ratio includes transfers of funds into or out of farm equity or capital reserves. The ratio identifies the way in which the choice to consume now or in the future is balanced, through the effect of decisions on present consumption, weighed against the resultant influence of this on expected future consumption opportunities (interest cost). High ratios suggest that present household consumption is restricted and therefore stressed. Ratios close to zero would reflect contentment with the utility of current consumption relative to expected future consumption.

IV.- COMPARATIVE FINANCIAL ANALYSIS :

(Standards of comparison)

Absolute figures or ratios are close to being meaningless unless compared to another figure. The successful use of ratio analysis, requires that there be well-established standards or norms for comparison, as well as a general feeling for the acceptable limits to deviation from these norms (Bernstein: 1989). As Sidney and Everett (1986) explain "financial comparative analysis is the process of comparing information from two or more financial statements". Because there is no nationally recognized, or readily available publication of financial ratios for farm businesses, the use of ratio analysis is much more limited in agriculture. The efficiency evaluation of the farm, can proceed at several levels. As explained by Calkins and DiPietre (1983); Kenley (1989), Stickney (1990), there are three main standards of comparisons : Time Series or Trend analysis; Cross Section or Comparative analysis and Ex-ante or Pro-forma projection analysis.

Time Series Analysis:

Time Series or Trend Analysis, uses the past history of a firm for comparison. This is the most used standard for comparison. Admittedly it is not available to a new firm or for a new activity. Sufficient information must be available from past performance to asses the progress of the farm over time, and this is not always possible. By looking at a trend in a particular ratio, one sees whether that ratio is falling, rising, or remaining relatively constant. From this, a problem is detected or good management is observed, and so enables weak points in the farm operation to be detected. Similarly, the impact of economic conditions (recession, inflation), and farm-specific conditions (new technology and/or management strategies), can be observed as the time pattern of ratios is examined. Issues that should be raised before using ratios from past financial statements as a basis for interpreting ratios for the current period include:

1. Has the farm manager made a significant change that can affect the comparability of financial statements over time ?
2. Has the farm manager changed the method of accounting over time?

According to Westwick (1987), comparing the firms' own present performance with its past has some disadvantages. One of them is that the standards achieved in the past may have been poor, and to compare with them may encourage a dangerous degree of complacency. Any improvement during the current year, might still leave the firm at an undesirable level. Another disadvantage is that an apparent improvement or downturn in the firm's performance, may be the result more of a change in the economy rather than of an increase or decrease in management efficiency. The third disadvantage mentioned by Westwick is that as the state of technology is continually changing, a level of achievement which may have been perfectly satisfactory in the past, is no longer acceptable now.

Comparisons with Like Farm Business (cross-section analysis) :

Comparisons between similar farms are of considerable assistance when the data base is adequate. Care should be taken that the comparison identifies farms of similar size and nature. Only a limited amount of comparable data is available at present, but more should become available as farm management accounting extends. The service provided by the Ministry of Agriculture and Fisheries is most useful but at present is available to only a relatively small number of farmers. Comparisons of financial performance are often based upon relative rather than absolute standards. The farm business is said to have a "good" performance if its record is above average. However, relative comparisons can be misleading if the farm business is compared to either "above average" or "below average" farms. Such comparisons represent the basic thrust of ratio analysis. Comparisons of ratios calculated from data in the financial statements of one farm are made with similar ratios from a number of farms as published in a tabulation of inter-farm comparisons. This may provide evidence that suggests that the activities of the farm whose financial statements are under examination, is performing better, or worse, than the average. The major task in performing a cross-section analysis is identifying the other farms used for comparison. It is desirable to select farms that have similar orientation, resources and size. According to Johnson et al. (1988), there may be few farms that meet these criteria.

One common approach is to use average ratios, such as those of "All Classes" (Class No 9) published by New Zealand Meat and Wool Board Economic Service (NZMWBES). These published average ratios provide some sense of the overall performance of a sector, and they can be useful as a basis of comparison as long as their possible limitations are recognized. They should be taken as possible indicators of the directions in which improvements in management might be effected, rather than regard these standards as ends in themselves (see Blagburn: 1961; Candler and Sargent: 1964).

Caution in using averages :

Financial statement analysis is an art, which requires judgement decisions on the part of the analyst. Caution must be taken so as not to place complete belief on ratios computed or comparisons made. Penson (1987) and Jonson et al.(1985), suggest a number of situations which require the analyst to use care :

* Farms which use different accounting methods, may have dissimilar year ends. Furthermore, farms which have differing financial policies might be included in the same sector average; capital-intensive farms are grouped with labour-intensive ones; farms utilizing large amounts of debt may be in the same average as farms which avert the risk of the use of debt.

* Some averages, if based on small samples, may not be representative of the sector. In addition, ratios may have alternative forms of computation. Ideally, the analyst should compute the enterprise ratios on the same basis as are used for sector comparisons. This is often not possible.

* Finally, ratios are not absolute norms. They are general guidelines to be combined with other methods in formulating an evaluation of the financial condition of a firm.

Pro-forma or Ex-Ante Analysis:

According to Penson and Lins (1980), a pro-forma statement is sometimes called a target statement. It is based upon projected financial statements. These projections may be done for existing operations, or for a modification to existing operations. For Gill (1990) it is an ideal approach to Comparative analysis, because it is one that incorporates the farmers' financial objectives. Some examples are:

a) **Comparisons with notional standards:** these are merely preconceived ideas and have no objective basis. They should be used, only when no other information is available.

b) **Comparisons with budgeted figures:** If the budget has been carefully drawn up, and particularly after a number of year's experience in management accounting, this can be the most useful comparison of all. Experience allows the budgeted estimate to be tempered by the farmer's former memories of discrepancies between expectation and outcomes.

c) **Comparison with objectively determined standards:** At the present time, no objectively determined standards are available in New Zealand except to the extent that the Meat and Wool Board Economic Service provides data that are essentially district averages (pseudo homogeneous groups of firms identified by production system similarities). As a consequence these reflect the good with the bad.

Ideally, the use of all types of Comparative analysis would be best. Trend analysis, averages comparison, and pro-forma or ex-ante analysis, will give support to findings and provide a concrete basis for problem solving.

III.- MANAGEMENT BENCHMARKS FOR COMPARISONS BETWEEN SHEEP AND BEEF FARMS IN NEW ZEALAND:

An analysis of New Zealand sheep and beef farm accounts using some of the financial ratios described (obtained from NZMWBES data (1959-1990)) is shown in Table 1. They give insight to the overall impact of policy and market changes on the financial viability of these farms and the onset of financial stress suffered by them through this period. Le Heron (1989), Sandrey and Reynolds (1989;1990), Johnston and Frengley (1990), Frengley and Johnston (1992), provide the necessary background and a useful chronicle of political goals and forms of government interventions through and after deregulation in 1985.

	RATIOS		High Country No 1 NZMWBES		SI Intensive Finishing No 7 NZMWBES		All Classes Averages NZMWBES	
			59/90	85/90	59/90	85/90	59/90	85/90
Activity Ratios	Capital Turnover (%)	Av.	**19.4**	**22.1**	**19.4**	**24.4**	**18.4**	**21.5**
		CV	0.2	0.1	0.2	0.1	0.2	0.1
	Interest as a % of Total Farm Expd.	Av.	**8.8**	**12.5**	**15.5**	**27.7**	**13.5**	**23.4**
		CV	0.4	0.3	0.4	0.1	0.4	0.1
Profitability Ratios	Return on Capital (%)	Av.	**4.6**	**7.1**	**5.3**	**16.9**	**4.6**	**4.7**
		CV	0.5	0.3	0.3	0.6	0.3	0.2
	Return on Assets (ROA) (%)	Av.	**5.8**	**8.1**	**7.7**	**9.9**	**6.3**	**7.5**
		CV	0.4	0.3	0.2	0.1	0.2	0.1
	Return on Equity (ROE) (%)	Av.	**5.8**	**7.9**	**7.6**	**8.0**	**6.1**	**5.5**
		CV	0.5	0.3	0.3	0.3	0.3	0.2
Solvency or Financial Leverage Ratios	Equity to Total Assets (%)	Av.	**81.1**	**80.3**	**76.7**	**67.4**	**76.7**	**71.6**
		CV	0.1	0.1	0.1	0.1	0.1	0.03
	Long-Term Debt to Equity (%)	Av.	**16.4**	**16.7**	**24.5**	**39.4**	**23.3**	**30.7**
		CV	0.4	0.3	0.4	0.2	0.3	0.1
	Financial Leverage (ROE/ROA) (number)	Av.	**0.95**	**1.00**	**0.99**	**0.81**	**1.0**	**0.73**
		CV	0.17	0.1	0.14	0.1	0.2	0.1
	Time Interest Earned (number)	Av.	**6.1**	**4.9**	**5.4**	**2.3**	**5.2**	**2.1**
		CV	0.6	0.3	0.5	0.2	0.6	0.1
	Interest as % of Gross Farm Income	Av.	**6.7**	**8.5**	**10.6**	**20.6**	**9.8**	**18.6**
		CV	0.5	0.3	0.5	0.1	0.5	0.1
Liquidity Ratios	Current ratio (number)	Av.	**0.57**	**0.20**	**0.51**	**0.5**	**0.5**	**0.53**
		CV	0.80	0.2	0.35	0.2	0.3	0.1
	Debt Structure ratio (%)	Av.	**5.4**	**6.3**	**4.9**	**6.6**	**4.5**	**5.6**
		CV	0.3	0.1	0.3	0.3	0.3	0.1
Financial Stress Ratio	Adj. Stress Household Consumption	Av.	**0.62**	**0.76**	**0.48**	**0.99**	**0.53**	**1.02**
		CV	0.55	0.2	0.59	0.1	0.58	0.1

Table 1.-Financial Ratios for N.Z. Sheep and Beef farms (Averages values). Source: NZMWBES.

Financial ratios remain unaffected when there are changes in the value of the monetary units over time, as is true for the periods examined in this paper. Figure 1 contains selected financial ratio for the following NZMWBES classes: High Country (No 1), SI Intensive Finishing (No 7) and the All Classes average. The selected financial ratios provide useful references to the expected value of each ratio for sheep and beef farms in New Zealand. They can be used as benchmarks or standards which enables comparisons when evaluating the financial performance of a farm, but with the limitations of any financial data (see Popoff & Cowan:1985; Candler & Sargent: 1964; and Blagburn: 1964); and/or when using averages (see Penson: 1987, and Jonson et al.:1985).

To obtain reliable information when evaluating any financial results, we should choose the most similar farm or groups of farms to be compared with the farm data to be analysed. We must also accept the recommendation of Melichar (1985), Lins et al(1987), and Penson (1987) that financial analyses should include a group of ratios rather than single ratios in their assessments.

The Coefficient of Variation (CV) calculated for each ratio in Fig 1 measures variability relative to the mean of the probability distribution (standard deviation divided by the mean). It provides useful information about the reliability of each ratio, by describing its variability through the most recent 31 years of sheep and beef farming in New Zealand. A comparatively low CV implies the distribution has less variability in relation to its mean or expected value than others. Conversely, the higher the CV the more this ratio can be expected to vary.

The total period under review (1959-90) is too long to provide suitable information for comparison with recent years. Political, economic and trading conditions have varied considerably in that time and make difficult direct comparison with the post-deregulation period from 1985. However the 30 year period provides information about the range within which the ratios may be expected to vary in the future. The averages are valuable in order to appreciate the likely values representing "good and bad" times for agriculture, especially when partitioned into smaller time periods (Johnston and Frengley, 1990) reflecting the effects of the different agricultural policies that have been implemented through the last 31 years.

Following deregulation in 1985, average sheep and beef farms have suffered increased financial stress reflected by the highest stress ratios experienced for each farm class within the last 31 years. Their financial problems are also reflected by their increasingly impecunious state, evidenced by changes to Financial Leverage, Solvency and Liquidity ratios. By contrast the Activity or Profitability ratios (apart from the ROE) have generally improved over the last 5 years.

Despite these ratios reflecting a more efficient utilization of farm capital in producing Gross Farm Income after 1985 there are problems evidenced in other ratios. The deterioration of the Solvency ratios observed in the 80s implies that the "improvement" in returns or activity has not been generated by increased profits resulting from deregulation. It is more easily attributable to other economic factors such as inflation and the decline in land values. Reflecting this, post-deregulation Leverage ratios have worsened in comparison with the 31 year period. The real Equity of sheep and beef farms in N.Z. continually fell through the period of commodity price support in the early 80s, stopped falling after deregulation but has remained low.

The legacy of debt incurred in the early 80s during the government support period which ended with deregulation in 1985, impacted severely on farm household expenditure. Farmers have continued to disinvested since 1986 and real drawings have fallen. Their interest expenses as a percentage of GFI has risen and they have increased their long-term debt to equity ratio. The farmers whose long-term debt to equity was largest (South Island Intensive Finishing, and which influences the All Classes Average) have been consistently highly stressed in the last five years . With increasing debt and interest expenses household consumption has become increasingly constrained. The resultant rise in the Adjusted Household Consumption Stress ratio reflects the constraints affecting all sheep and beef farmers.

Although High Country farms (No 1 NZMWBES) have been more stressed in the last five years than beforehand, they have been less stressed than the other classes. In their mountain environment they have perceived risk associated with debt to be more significant than in low country areas and have generally been more debt averse. Their stress stems more from illiquidity than from leverage. Despite being more solvent than other farm classes, their household consumption stress has also risen.

Since deregulation sheep and beef farmers have been forced to change their objectives in order to survive in the new economic environment. Emphasis on production and output has fallen in comparison with an awareness of and orientation to market opportunities. Marginal utility of consumption has risen (Financial Stress ratio) and is more strongly influencing farm expenditure decisions. Small and highly productive SI Intensive Finishing farms have been most affected. Conservative and less productive High Country farms have been better adapted to the new conditions. Their farm families have been less affected by financial stress than low country farmers through the last 5 years, the reverse of their status before 1985. Sheep and beef farmers have experienced considerable difficulties making adjustments to familiar management sytems to recover their profitability; equity recovery lags behind.

The ratios that have varied most (highest CV) during the 31 years period considered here, usually include a measure of interest payments. Borowing policies adopted by farmers have been a principal cause of variability for sheep and beef farm financial ratios. Financial Leverage ratios (ROE/ROA) after 1985 were lower than 1, indicating that the return on assets was greater than the return on equity. There was no economic advantage to be gained by further investment using debt. On the other hand the low Times Interest Earned ratios after 1985, particularly for SI Intensive Finishing and All Classes farms, reflect their problems meeting debt obligations. For them, interest payments have been high relative to the earnings available to meet the payments.

Deterioration in the financial health of sheep and beef farms has been ongoing since the early 1980s and accelerated after deregulation. As a result, the financial situation of sheep and beef farms has been depressed since 1980 and for farm families the last five years have been highly stressed; more so than at any time during the previous decade (Frengley and Johnston, 1992, 18-23). High levels of financial leverage and interest expenses incurred prior to deregulation worsened subsequently and have dominated the measures reflected in the ratios.

CONCLUSIONS :

Farm managers' chosen programmes are based on decisions derived from an immense variety of information, experiences, facts and data available to them. Information sources as diverse as weather forecasts, socio-political, economic and family are important. All management programmes reflect expectations and outcomes which rely on historic information. There is no other. Among the most useful of these data sources is the historic financial information which is the output of the farm's system of accounting, presented as formal financial statements and suitable for use by others. As an information source on which to base revised management decisions they are invaluable as they quantify the outcome of past decisions in the use of the entire mix of resources. But as Bernstein (1989) cautions, "such data cannot be intelligently used in financial analysis without a thorough understanding of the accounting framework of which they are the end product." Unless the financial data are related to espects of production, the farm accounting system will lose its maximum potential value. It is through suitable measures of performance, essentially as ratios indicating financial strengths and weakness, that financial statements are enabled to fulfill their optimum role as a guide to ongoing decisions for management planning and control.

Cross-sectional data obtained from a number of farmers through a central organisation which standardises analyses and inter-farm comparisons will yield additional information. Ideally all important aspects of performance would be revealed by the ratios selected for the analyses. Support from supplementary information relating to firm resource characteristics and management practices will further assist farmers in their comparisons to better revise their management decisions. Calkins and DiPietre (1983) summarized the most important aspects that should be understood when using Ratio Analysis to measure farm performance :

* first, no simple ratio is adequate to properly evaluate farm performance. An appropriate set of ratios should be employed. Remember that both physical and economic data, are necessary to properly evaluate the allocation of resources.

* second, the farm manager must be able to monitor selected key weak points on the farm. Careful selection and consistent application of appropriate efficiency measures, are the first steps in determining where opportunity for improvements lies.

* often the same ratios are of interest to different categories of users, and some ratios are of more interest than others to a particular user group. Any one financial ratio can usually meet only part of the information needs of different categories of user.

* sometimes in analyzing ratios, negative profit figures will be encountered. Analysis of ratios that have negative numerators or denominators is meaningless and the negative sign of the ratio should simply be noted.

* finally, a number of ratios that supplement each other, and are calculated from the same balance sheet, often need to be reviewed not at one point in time but rather, if possible over a period of time so that both favourable and unfavourable trends can be seen and efforts made to ascertain the cause of these trends.

The main limitation of financial analysis implementation as a measure of financial performance for sheep and beef farms in New Zealand, is imposed by inadequacies in the data available to analysts. The necessary technology to interpret the data has been tried and proven. What is needed is a general understanding of the limitations and specific purpose, usefulness and limitations of the ratios as described in this paper. There is a clear lack of an agreement between farm analysts, about accounting methods, ratio selection and standards of comparisons, to use within and between farm firms. A consensus view of an acceptable framework with which to obtain reliable conclusions from financial analyses is required.

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An Investment Perspective on the Productive Value of Farm land

A Report Commissioned By The Rural Resource Unit, MAF Policy

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1.00 Summary

This paper compares the market value of farmland with estimates of its productive value. The aim is to identify a method of calculating productive value that can be used to forecast market value, and to see how the relationship between productive and market value has altered as the New Zealand economy has been deregulated. The analysis is based on sheep/beef and dairy farm data from 1970 onwards.

Productive value is calculated by capitalising farm profit. For each particular year from 1970 onwards, estimates of productive value are made using farm profit and cost of capital data specific to that year (current productive value), average profit and cost of capital data from that year to the present day (average productive value), and actual profit and cost of capital estimates for each year from that year to the present day (actual productive value). The estimates so derived are then related to the market values for each particular year.

Consideration is also given to possible causes of differences between market and productive value. Of particular interest is the ability of land to increase in value over time, and its attractiveness for lifestyle or non commercial reasons.

Farm profitability is calculated in terms of trading profit before debt servicing and with adjustment for the capital tied up in livestock and plant and equipment. Rural Bank market indicator interest rates are used to determine capitalisation rates and Producer Board profit and loss and balance sheet survey data is used to calculate profit and levels of investment in stock and plant.

The analysis found that compared to inflation, and as suspected, land has performed well as a store value. This ability was lost during the transition to a deregulated economy, but now appears to be returning.

For both sheep/beef and dairying, good post deregulation correlations were found between productive value calculated using profit and cost of capital data specific to a particular year, and market value in the same year.

The paper concludes that Rural Bank interest rates provide a worthwhile proxy of the average cost of capital, and that current productive value can be used to forecast changes in market value. Recommendations for further development are also made.

2.00 Background

MAF Policy wish to be able to make reliable estimates of the market value of farmland as part of their intelligence reporting and policy option testing responsibilities. They are also interested in the relationships, if any, of return on capital from cash income and capital gain. Further, how these relationships have changed as New Zealand has moved from a regulated to a relatively deregulated economy is also of interest.

This assignment compares the market value of farmland with estimates of its productive value. The purpose is to identify an appropriate methodology for estimating productive values, and to see whether productive value can be used to forecast the impact of changes in farm profitability on market values.

3.00 Terms of Reference

Generally: to discuss differences between the market and productive value of farm land; to identify and test a suitable method of estimating productive value, and; to see whether productive value can be used to predict market value.

More specifically the terms of references are:

1. to provide estimates of the productive values (derived by capitalising farm income as an annuity) of sheep/beef, and dairy farms from 1970 to 1990, depending on the availability of profit & loss and balance sheet data;

2. to validate estimates of productive valuation against ex-post estimates of productive valuations using historical farm income figures over time;

3. to compare productive values with market values for the corresponding periods, and examine relationships with inflation, cost of capital and capital gain, and;

4. to develop spreadsheet programmes to estimate the productive and (if possible) market values of sheep/beef and dairy farms.

4.00 Market versus Productive Value

The market or capital value of farmland is defined in the New Zealand Valuation of Land Act (1951) as:

"... the sum which the owner's estate or interest therein, if unencumbered by any mortgage or other charge thereon, might be expected to realise at the time of valuation if offered for sale on such reasonable terms and conditions as a bone fide seller might be expected to require."

The literature identifies 3 broad types of value that contribute to determination of market value of farmland viz.

Market Value = Productive Value + Speculative Value + Consumptive Value

Productive value relates to the ability of the farm to generate income (land rent). Speculative value relates to the ability of land to act as a store of value (like gold or art). Consumptive value relates to the non commercial appeal of land as a place to live.

While there is no generally accepted valuation model that estimates overall market value, there is consensus in the literature that the market value of farmland is primarily determined by land rent and hence productive value. Furthermore, it is recognised that speculative or capital gain value is some function of productive value. This fact is evidenced by recent increases in farm prices that have occurred during a period of rising farm profitability and low inflation.

To the extent that speculative and consumptive values manifest themselves in financial terms they too form part of the overall investment analysis to determine market land price. However, consumptive value and to a lesser extent speculative value estimation will likely lean heavily on behavioural sciences beyond the scope of this assignment.

This assignment accepts as a start point that productive value is the primary determinant of market value, and seeks to develop an approach to productive valuation estimation that is consistant with this relationship. Through a comparison of capital gain and inflation levels it also looks at the ability of land to act as a store of value.

5.00 Concept of Productive Value

From an investment analysis point of view the productive or investment value of a farm is equal to the net present value of the future income streams that farm will generate. Provided the cost of investing in a farm is less than the present value of the future benefits the farm will generate, the investment is worthwhile.

Farming income will vary between years according to seasonal, market, financial, and management factors. This variability is usually accounted for when making estimates of uncertain future income streams, by using 'average' estimates of income and expenditure items. The literature suggests that these estimates are most strongly influenced by current season income and expenditure levels, followed by those that existed the previous season.

Provided there is no farm development taking place, the effect of averaging future farm income streams is to create a series of cashflows of constant amount equivalent to an annuity. In this situation the productive value of a particular farm is equal to the present value of the annuity it is estimated that it will generate.

The formula for the present value of an annuity is:

$$PV=A[(1-(1+r)^{-n})/r]$$

where A is the annuity, r is the discount rate, and n is the number of years.

Where an annuity continues in perpetuity, as is the case with farm income, unless the farm is sold, the formula for the present value of an annuity simplifies to:

$$PV=A/r$$

It is this formula that is used to estimate productive value of farmland. The following sections expand on the calculations of the annuities and discount rates.

6.00 Calculation of the Annuity from Farming

The annuity from farming or land rent can be calculated as the Economic Farm Surplus (EFS) generated by a farm as a going concern, less an allowance for ancillary capital in livestock and plant and machinery.

Annuity From Farming = Economic Farm Surplus - allowance for ancillary capital

Economic Farm Surplus

EFS is defined as the return available to the owner-operator of an unencumbered farm after allowance for his/her labour and management input. In practice it can be calculated for any farm as the farm working account profit with interest charges added back, and adjustments for changes in livestock numbers, non maintenance input levels, and wages of management i.e it defines the net cash surplus if the farm were being farmed on a static maintenance-only basis. It is suggested that the allowance for the owners labour and management input be based on the average level of drawings for a particular farm type, class and year.

EFS is considered the appropriate measure of farm trading profit to use when estimating annuities from farming. It provides a 'steady-state' estimate of profitability consistent with the calculation of an annuity, and does not include expenditure on debt servicing.

Indebtedness

Although interest charges are a legitimate trading expense, level of indebtedness has no influence on productive value, and the inclusion of debt servicing charges only complicates unnecessarily the calculation of productive value. If interest charges are deducted in the calculation of the annuity from farming, the value of loan money being serviced must be added as a year zero benefit. The value of the loan money off-sets the reduction in the annuity from farming, such that productive value does not change as indebtedness increases from zero.

At high levels, indebtedness will affect productive value through a higher discount rate that reflects a margin for increased financial risk (also see section 7).

Tax

From an investment point of view the annuity and discount rate must be treated consistently for tax. If, as proposed, the annuity is estimated using EFS (i.e the annuity includes an allowance for depreciation), taxation will have no impact on productive value.

$$PV = \frac{A(1-t)}{R(1-t)} = \frac{A}{R}$$

In the interests of simplicity therefore, the calculation is made pre-tax.

Inflation

As for tax the annuity and discount rate should be treated consistently for inflation. The difficulty is that the annuity is both nominal and real at the same time, so that arguments can be made for and against adjusting the discount rate for inflation.

For practical reasons it is preferred that the discount rate not be adjusted for inflation. During much of the period under review the rate of inflation was well in excess of the cost of capital. To adjust the discount rate for inflation consistent with capital investment theory, would have resulted in negative discount rates during high inflation years. Such an adjustment is theoretically illogical.

Now that inflation is in low single figures, the effect of adjusting or not adjusting the discount rate for inflation is far less significant, as is the difference between productive value estimates that result.

Allowance for Ancillary Capital

The annuity from farming is intended to represent the financial return on investment in land and buildings, not the going-concern investment. To arrive at land and building annuity figure a deduction must be made to compensate for the return on ancillary investment in livestock and plant and machinery. This is done using market values and a rate of return prescribed by the cost of capital.

7.00 Calculation of Discount Rate

Investment theory suggests that the weighted average cost of capital (WACC) is the appropriate discount rate to use in productive valuation estimates. WACC will vary between individuals depending on their debt financing arrangements and their expectations for different equity investments. Calculating WACC's can be complicated and time consuming.

Different individuals have different discount rates and expectations of farming profit, and it follows they will also assign different and personal productive values to any particular property. Thus, a property can be expected to have an average value and an associated range of values. This assignment is concerned with estimating average productive value at a point in time, in order to make comparison with average market value at the same point in time.

Because of the difficulty in estimating an average discount rate a proxy estimate is required. The Rural Bank market indicator rate is used as this proxy. The Rural Bank is the main farm lender in New Zealand and, since deregulation of the financial markets in the mid 1980's at least, their lending rates will have incorporated competitive margins for inflation, financial risk, and the time value of money.

8.00 Approaches to Productive Valuation

Using historical data, it is possible to compare a point in time estimate of PV in any particular year (based on profit and discount rates prevailing in that year), with PV estimates based on either the actual annual cashflows subsequently experienced from that time to the present day, or the average of these cashflows. It is not possible to consider a productive value estimate based on real figures, because of difficulties in measuring real discount rates.

The following hypothetical data can be used to illustrate the difference between the approaches.

	1980	1981	1982	1983	1984	1985	1986
NCF	$100	$120	$80	$100	$140	$130	120
Discount Rate	9%	12%	10%	11%	13%	15%	12%

A 1980 estimate of productive value using 1980 profit and discount rate data would give a value of $1,111 ($100 profit divided by a 9% discount rate). A 1980 estimate of productive value using the average profit and discount rates between 1980 and 1986 would give a value of $966 ($113 average profit divided by a 11.7% discount rate). A 1980 estimate of productive value using the actual annual profit and average discount rate between 1980 and 1986 would give a value of $570 (annual cashflow discounted using a 11.7% discount rate).

In this assignment, productive value estimates are made from each of the above perspectives, to see which approach has the best correlation with market value. A pragmatic viewpoint would suggest that farmers use current or historical profit/ discount levels as the basis for assumptions about future levels. This paper considers how good current profit/discount levels are at estimating future levels.

Estimates of market and productive values are made for sheep/beef and dairy farms using producer board 'all-classes average' profit and loss and balance sheet data. Sheep/beef data is taken from the annual New Zealand Sheep and Beef Farm Survey carried out by the NZ Meat and Wool Boards' Economic Service. Dairy data is taken from the NZ Dairy Board's annual economic survey last published in 1987.

Except for depreciation rates, which were fixed at 10%, and allowances for management drawings, all figures were taken directly from producer board estimates. Depreciation rates were set at 10% to give a standardised estimate of the extent to which plant and machinery assets are used up in the course of a farming year. Historically, actual depreciation rates have been around 25%, reflecting tax incentives rather than asset use. Management allowances were based on a 1989 Farm Monitoring allowances for owner drawings. These figures were then adjusted to different years using the consumer price index.

9.00 Land as a Store of Value

Also of interest is the ability of land to act as a store of value. This ability is illustrated through a comparison of the consumer price index (CPI) and an index of farm capital gain calculated using balance sheet data derived by the two producer boards in consultation with Valuation New Zealand.

Figures 1 and 2 below compare indexes of sheep/beef and dairy farm capital gain with the CPI, and clearly show that, as expected, farmland has served to maintain its real value over time. These graphs support the argument that farmland does have a speculative value, and this finding is corroborated using independent Valuation New Zealand data sets (refer appendices).

Figure 1. Index of Sheep/Beef Farm Capital Gain vs Consumer Price Index

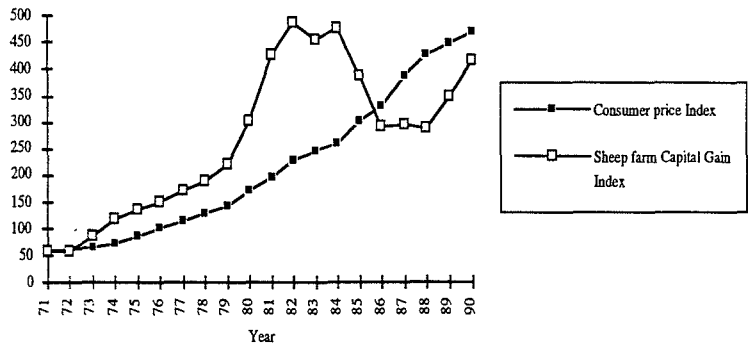
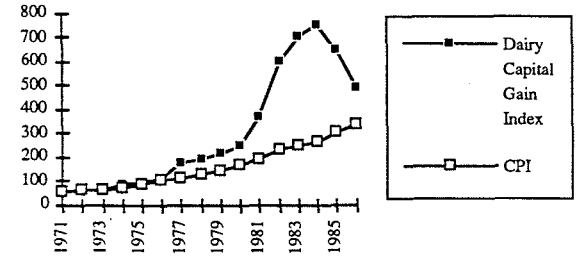


Figure 2. Index of Dairy Farm Capital Gain vs Consumer Price Index



Prior to 1984 farmland was appreciating at a faster rate than inflation. This was probably due to high levels of government assistance available at this time, being capitalised into land values.

Following deregulation in the mid 1980's, farmland decreased sharply in value suggesting there was a corresponding decapitalisation when assistance was removed.

The sheep/beef graph suggests that after the mid 1980's decline, prices stabilised and then again increased at a rate above the rate of inflation, so that by 1990 both the CPI and farm capital gains index were at a similar level. Although the dairy data stops at 1986, the more recent data from Valuation New Zealand shows that dairy farm values follow a similar pattern.

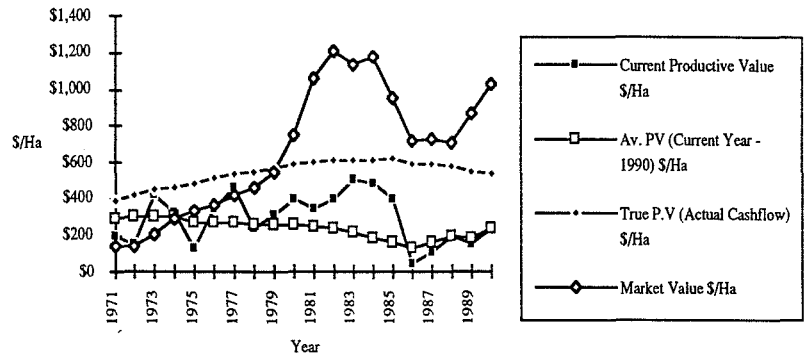
The indications are that farmland prices are now settling into a new post deregulation pattern that will see the speculative value of land preserved. It seems reasonable to assume that farm buyers are aware of this when they make their purchases, and accordingly factor some margin into sale prices.

10. Analysis of Values

Analysis of farm values between 1970 and 1990 is detailed in the appendices and discussed here.

For sheep/beef farms the only estimate of productive value to show any similarity to market or sales value, was the estimate based on current season's profit and discount rate (see figure 3 below). Estimates based on actual or average cashflows as discussed in section 8, bore no discernable relationship to market value.

Figure 3. Comparison of Sheep/Beef Farm Values



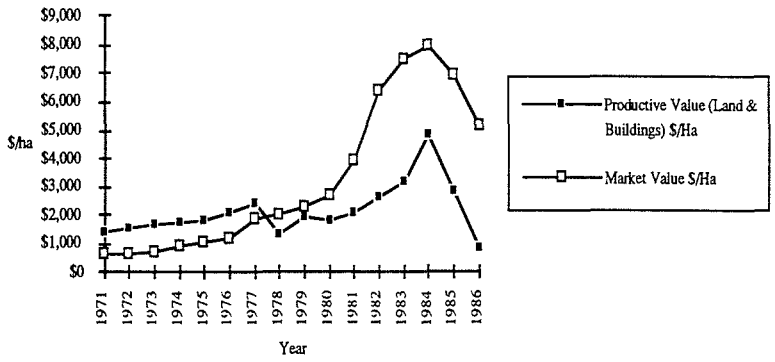
This analysis shows that from 1981 onwards there is a reasonably good correlation between sale price and 'current' productive value ($R^2 = 0.87$) according to the following formula.

Market Value = 657 + 1.05 x Current Productive Value

There is no obvious reason why a clear relationship between current productive value and market value should emerge post 1980. The effects of deregulation were not being felt until 1985-86.

A similar picture emerged when dairy farm values were assessed (figure 6), although data was only available until 1986. As for sheep/beef farms only current productive value showed any relationship with market value. It appears that there was a different relationship during the 1970's to that which emerged during the 1980's. The correlation between current dairy farm productive values and market values was high between 1971-1977 ($R^2 = 0.97$), and again between 1982-1986 ($R^2 = 0.96$). In the intermediate years when the new relationship was forming the correlation was low. Again there is no obvious explanation why there is a relationship between market and current productive values prior to 1980 for dairy farms and not for sheep, nor why a new relationship should emerge in the early 1980's prior to deregulation.

Figure 4. Dairy Farm Market Value vs Current Productive value



The post 1982 relationship between market value and current productive value for dairy farms is given by the following equation.

Market Value = 4,712 + 0.74 x Current Productive Value

When predicted market values for both sheep/beef and dairy farms are plotted against actual market values there is an extremely good fit (figures 5 and 6).

Figure 5. Sheep/Beef Farm Predicted Market Value vs Actual Market Value

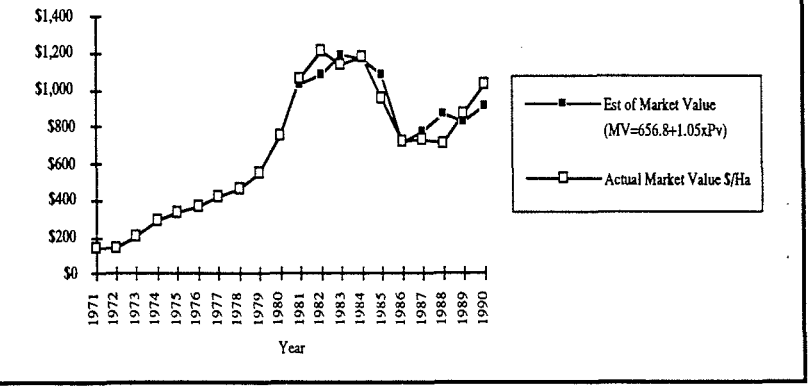
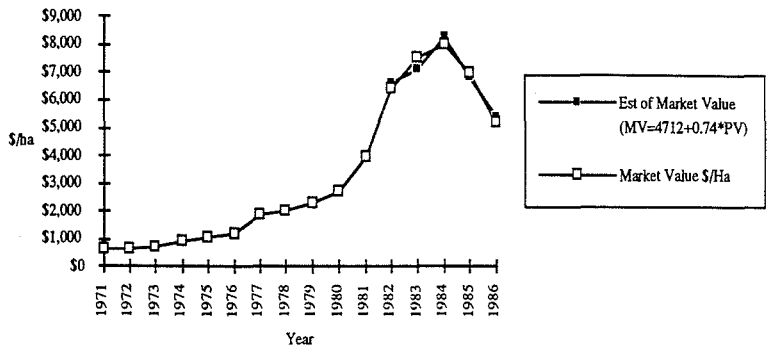


Figure 6. Dairy Farm Predicted Market Value vs Actual Market Value



While current productive value provides a basis for predicting market value, the fact that there is a gap between the 2 values says that current productive value as calculated does not fully account for market value. Tables 1 and 2 below show how the gap between market and current productive value has widened over recent years.

Table 1. Comparison of Sheep/Beef Farm Market and Current Productive Values.

Year	Market Value ($/ha)	Productive Value ($/ha)	Market Value/ Productive Value (%)
1971	$144	$193	74%
1972	$147	$153	96%
1973	$211	$420	50%
1974	$290	$327	89%
1975	$344	$130	258%
1976	$369	$344	107%
1977	$422	$467	90%
1978	$467	$243	192%
1979	$545	$309	176%
1980	$747	$399	187%
1981	$1,062	$350	304%
1982	$1,209	$401	302%
1983	$1,131	$502	225%
1984	$1,183	$483	245%
1985	$959	$405	237%
1986	$724	$50	1,447%
1987	$735	$108	681%
1988	$712	$202	352%
1989	$867	$158	548%
1990	$1,029	$240	429%

Table 2. Comparison of Dairy Farm Market and Current Productive Values

Year	Market Value ($/ha)	Productive Value ($/ha)	Market Value/ Productive Value (%)
1971	$622	$1,398	45%
1972	$650	$1,515	43%
1973	$703	$1,693	42%
1974	$907	$1,753	52%
1975	$1,067	$1,792	60%
1976*	$1,183	$2,072	57%
1977	$1,909	$2,451	78%
1978	$2,024	$1,363	148%
1979	$2,279	$1,951	117%
1980	$2,687	$1,826	147%
1981	$,3959	$2,117	187%
1982	$6,436	$2,613	246%
1983	$7,529	$3,177	237%
1984	$8,003	$4,823	166%
1985	$6,950	$2,876	242%
1986	$5,203	$871	597%

If, as assumed, market value is the sum of productive value plus speculative value plus consumptive value, it is to be expected that productive value will be less than market value. In concept, the margin between current productive and market value (i.e $657/ha for sheep beef and $4,712/ha for dairying) is equal to the sum of speculative and consumptive values.

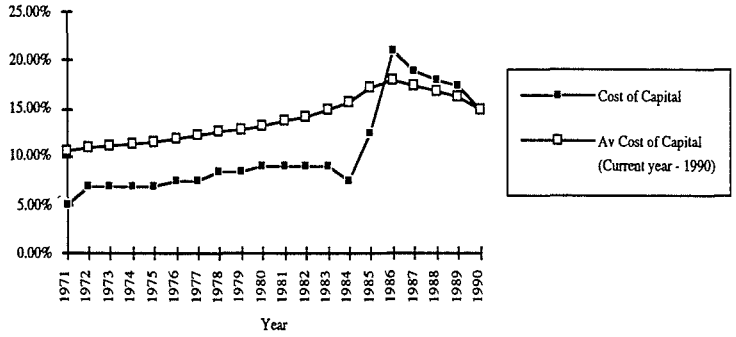
Speculative value is influenced by both inflation and changes in productive value. In times of low inflation, productive value will be a more important determinant of speculative value. Where market value is more greatly influenced by current productive value (i.e the slope of the regression equation is greater) as it is for sheep/beef compared with dairying, then the premium of specultive/consumptive value over productive value, is relatively bigger. This occurs because of a compounding effect of changes in productive value which affect market value directly through itself, and indirectly through its effect on speculative value.

A further factor contributing to the gap between market and current productive values may be that the Rural Bank indicator rate, while proving a most satisfactory proxy for an average discount rate, is over estimating the average WACC of farm buyers. This could be because farm buyers have a lower expected return on equity capital used for farm purchase because of a high anticipation of future capital gains.

Comparison of current EFS with average EFS (ex-post) showed no direct relationship. This is not unexpected given the high levels of inflation experienced through the late 1970's - early 1980's. However, given that there is no relationship between productive value estimates based on average profitability or actual profitability in subsequent years, and market values which are instead based on current profit estimates, this lack of relationship is neither surprising nor of significance.

Comparison of current cost of capital with average cost of capital showed that there was a close relationship up until the time of deregulation in the mid 1980's. Again this is not unexpected given that interest rates over that time were largely fixed by government fiat. In recent years there are signs that a new relationship is forming and given that the government maintains it's goals of low inflation and low interest rates, it could be expected that current cost of capital would equate very closely with average cost of capital.

Figure 7. Current Cost of Capital vs Average Cost of Capital



Comparison of the historical level of trading profit and capital gains (tables 3 and 4) confirms that the bulk of the return from farming comes from asset appreciation. Further, in any particular year, the level of capital gain is related to trading profit such that as trading profit rises and falls, so too does the level of capital gain. This comparison also supports the regression analysis that defines market value as a multiple of productive value.

Popular opinion would suggest that the relative level of farming returns indicated in tables 3 and 4 are widely understood by farm buyers and sellers, and that sale values reflect an expectation that capital gains will continue to be received.

Table 3. Return on Sheep/Beef Farm Capital

Year	EFS from Land % Return	Capital Gain % Return
1971	9%	
1972	10.2%	2.1%
1973	17.5%	43.5%
1974	10%	37.4%
1975	4.2%	15.2%
1976	9.2%	10.5%
1977	10.7%	14.4%
1978	6.9%	10.7%
1979	8.1%	16.7%
1980	7.6%	37.1%
1981	4.9%	42.2%
1982	4.7%	13.8%
1983	5.8%	-6.5%
1984	5.0%	4.6%
1985	9.7%	-18.9%
1986	8.3%	-24.5%
1987	10.9%	1.5%
1988	11.8%	-3.1%
1989	9.1%	21.8%
1990	9.2%	18.7%

Table 4. Return on Dairy Farm Capital

Year	EFS from Land % Reurn	Capital Gain % Return
1971	12.7%	
1972	19.1%	4.4%
1973	19.5%	8.2%
1974	15.7%	29%
1975	13.6%	17.7%
1976	14.9%	10.8%
1977	10.8%	61.5%
1978	7.3%	6%
1979	9%	12.6%
1980	8.3%	17.9%
1981	7.1%	47.3%
1982	5.3%	62.6%
1983	5.4%	17%
1984	5.9%	6.3%
1985	8.1%	-13.2%
1986	9.5%	-25.1%

11.00 Discussion and Conclusions

This analysis suggests that current productive value can be used to predict the market value of both sheep beef and dairy farms. Some caution is needed however. While there are good correlations between market and current productive values for both dairy and sheep and beef farms over recent years, data is limited and it is probable that the relationship between market and current productive value will be an evolving one. It will be important, therefore, to keep validating or redefining the relationship as time goes by. In the short term the relationship is likely to modify as the impact of lower inflation comes through into sale figures.

The gap between market and current productive value comprises elements of consumptive and speculative value. Speculative value of land is determined by both inflation and productive value, and the lower inflation rates of the 1990's will raise the relative importance of productive value as the underlying source of speculative value. As sale and profit data related to the early 1990's becomes available it is likely that the correlation between market and current productive value will strengthen further. The premium of market value over current productive value is also likely to reduce as effects of high inflation rates are eliminated.

It will be important therefore to annually update the correlation as more recent sales, EFS and interest rate data becomes available. Because the relationship may continue to evolve it may be necessary to consider using only recent data so that as each new data set comes to hand, the oldest data set is drop off the back end.

It will also be important to analyse trends in changes in regression equations. Changes in 'R^2' values will signal changes in the way market values are determined. Changes in 'b' values will indicate changes in the relative importance of speculative or consumptive value. Changes in 'a' values will indicate changes in the stability of market values in the face of changes in current productive value.

Used sensibly and with careful interpretation, predictions of market value and the factors influencing market values would provide a valuable enhancement of MAF's routine Farm Monitoring programme, and its ability to analyse policy options that will impact on farm profitability.

For market value forecasts to be used in this way it will be necessary to carry out further market/current productive value regression analyses for different farm classes and enterprises in different geographic regions. For enterprises such as kiwifruit, the peculiarities of a single harvest crop and the impact of proximity to harvest on market value, further development work will be required. The limitations of scarce data pose additional problems.

Other areas for further work relate to more fully explaining the gap between market and current productive value. Of particular interest in this regard is knowledge of the importance and characteristics of consumptive value, and the closeness of the Rural Bank indicator rate to the market place average cost of capital. It may be that now that interest rates are above inflation rates (i.e positive real interest rates), a switch to real rather than nominal Rural Bank indicator rates would more closely equate market and current productive values, with a corresponding reduction in the apparent premium being paid.

Appendices

Appendix I: Dairy Values

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986
Area	64	67	70	70	72	70	70	69	67	66	63	64	64	64	67	67
Inflation Rate	9.43%	8.62%	6.35%	10.45%	14.85%	17.65%	14.00%	12.28%	12.50%	18.06%	14.71%	16.92%	8.33%	4.86%	16.60%	9.93%
Cost of Capital	5.00%	7.00%	7.00%	7.00%	7.00%	7.50%	7.50%	8.50%	8.50%	9.00%	9.00%	9.00%	7.50%	7.50%	12.50%	21.00%
Value of Plant & Machinery	$4,284	$5,054	$5,893	$6,605	$7,081	$7,394	$8,490	$9,281	$11,011	$14,023	$16,145	$20,467	$24,391	$28,366	$34,561	$33,894
Capital in Livestock	$8,938	$12,146	$12,451	$12,927	$13,016	$12,461	$12,159	$16,914	$20,666	$29,003	$48,240	$56,043	$61,470	$63,455	$75,655	$66,119
Gross Farm Revenue	$14,169	$19,101	$21,658	$23,335	$25,154	$25,654	$29,986	$30,911	$37,384	$44,724	$53,726	$66,279	$75,419	$84,977	$102,468	$99,900
Management Drawings	$2,296	$2,494	$2,652	$2,929	$3,365	$3,958	$4,513	$5,067	$5,700	$6,729	$7,719	$9,025	$9,077	$10,252	$11,955	$13,142
Working expenses	$6,311	$7,794	$8,839	$9,787	$10,641	$11,515	$13,920	$14,694	$16,781	$21,871	$26,596	$33,273	$37,178	$41,851	$49,194	$50,013
Economic Farm Surplus $/ha	$80	$124	$137	$142	$145	$135	$153	$148	$206	$223	$282	$343	$407	$469	$565	$496
Current Productive Value $/ha	$1,398	$1,515	$1,693	$1,753	$1,792	$1,515	$1,744	$1,363	$1,951	$1,826	$2,117	$2,613	$3,177	$4,823	$2,876	$871
MarketValue $/ha	$622	$650	$703	$907	$1,067	$1,183	$1,909	$2,024	$2,279	$2,687	$3,959	$6,436	$7,529	$8,003	$6,950	$5,203
Market Value/Productive Value	45%	43%	42%	52%	60%	78%	109%	148%	117%	147%	187%	246%	237%	166%	242%	597%
Capital Gain $/ha		$27	$53	$204	$160	$115	$727	$115	$255	$408	$1,272	$2,477	$1,093	$474	($1,052)	($1,747)
Capital Gain %/year		4.41%	8.19%	29.02%	17.68%	10.79%	61.47%	6.01%	12.60%	17.90%	47.43%	62.58%	16.98%	6.30%	-13.16%	-25.14%
Dairy Capital Gain Index	58	61	66	85	99	110	178	189	212	250	369	600	702	746	648	485
CPI	58	63	67	74	85	100	114	128	144	170	195	228	247	259	302	332

Year	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Area	542	553	563	565	501	508	517	524	533	536	534	525	522	518	516	516	519	530	514	516
Inflation Rate	9.43%	8.62%	6.35%	10.45%	14.86%	17.65%	14.00%	12.28%	12.50%	18.06%	14.71%	16.92%	8.33%	4.86%	16.60%	9.93%	16.57%	10.34%	4.92%	3.00%
Cost of Capital	5.00%	7.00%	7.00%	7.00%	7.00%	7.50%	7.50%	8.50%	8.50%	9.00%	9.00%	9.00%	9.00%	7.50%	12.50%	21.00%	19.00%	18.00%	17.50%	14.90%
Value of Plant & Machinery	$4,799	$4,910	$5,795	$6,635	$7,001	$7,246	$10,256	$12,178	$15,661	$18,707	$21,001	$23,312	$24,164	$25,752	$30,967	$29,038	$27,997	$27,205	$27,263	$30,323
Capital in Livestock	$27,984	$31,239	$51,895	$44,487	$31,653	$46,864	$61,010	$60,073	$97,804	$105,891	$100,833	$101,128	$95,233	$135,122	$145,059	$93,718	$134,000	$112,314	$123,496	$173,794
Gross Farm Revenue	$20,226	$22,941	$39,307	$38,198	$26,690	$40,750	$53,202	$49,831	$60,916	$77,668	$83,252	$95,586	$105,373	$104,775	$132,623	$106,318	$117,127	$126,178	$128,536	$143,356
Management Drawings	$2,090	$2,249	$2,391	$2,641	$3,034	$3,569	$4,069	$4,569	$4,718	$5,570	$6,960	$8,138	$8,816	$9,244	$9,895	$10,878	$12,680	$13,991	$15,990	$16,470
Working Expenses	$10,774	$11,748	$15,752	$18,393	$15,702	$19,304	$24,637	$27,060	$30,970	$39,770	$46,410	$54,974	$59,815	$62,142	$71,526	$61,336	$60,232	$65,073	$69,206	$74,978
Economic Farm Surplus $/ha	$13	$15	$37	$29	$14	$34	$45	$32	$44	$57	$52	$57	$66	$59	$93	$60	$80	$84	$79	$95
Current Productive Value $/ha	$193	$153	$420	$327	$130	$344	$467	$243	$309	$399	$350	$401	$502	$483	$405	$50	$108	$202	$158	$240
Market Value $/ha	$144	$147	$211	$290	$334	$369	$422	$467	$545	$747	$1,062	$1,209	$1,131	$1,183	$959	$724	$735	$712	$867	$1,029
Market Value/ Productive Value	74%	96%	50%	89%	258%	107%	90%	192%	176%	187%	304%	302%	225%	245%	237%	1447%	681%	352%	548%	429%
Capital Gain $/ha		$3	$64	$79	$44	$35	$53	$45	$78	$202	$315	$147	($78)	$52	($224)	($235)	$11	($23)	$155	$162
Capital Gain %/year		2.08%	43.54%	37.44%	15.17%	10.48%	14.36%	10.66%	16.70%	37.06%	42.17%	13.84%	-6.45%	4.60%	-18.93%	-24.50%	1.52%	-3.13%	21.77%	18.69%
Sheep/Beef Capital Gain Index	58	59	85	117	135	149	170	188	220	301	428	487	456	476	386	292	296	287	349	414
CPI	58	63	67	74	85	100	114	128	144	170	195	228	247	259	302	332	387	427	448	470

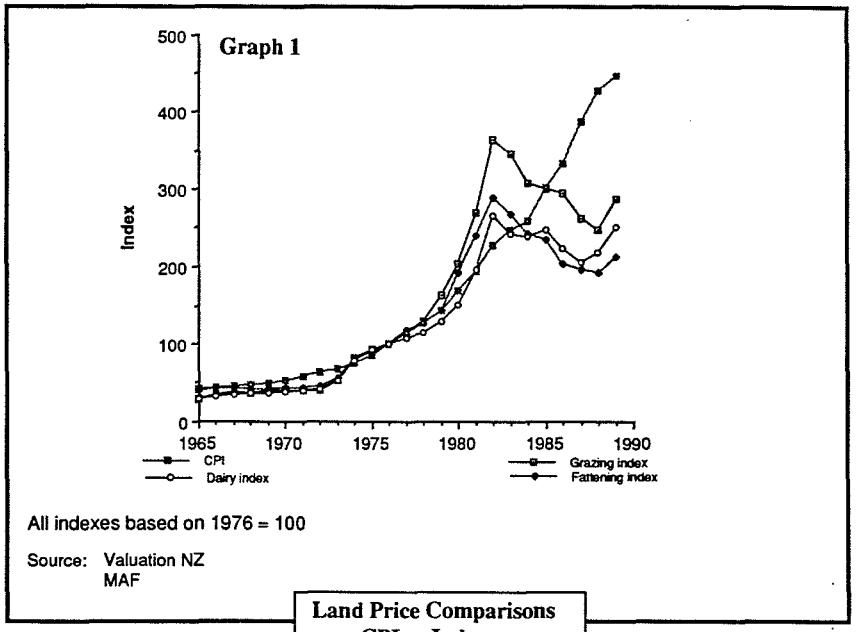
Appendix III

The following is an analysis of farm income and land values based on income data from MAF (derived from Meat and Wool Board Economic Service and Dairy Board information) and land value data from Valuation New Zealand. In respect of sheep and beef properties, Valuation NZ differentiate them into two categories; Grazing land (roughly equivalent to hill country), and Fattening land.

Historic Relationships

1. Speculative Value

This relates to the ability of land to act as a store of wealth - that is, to maintain its value in the face of inflation. A comparison of land prices with inflation (as measured by the Consumer Price Index [CPI]) over the period 1965 to 1989 is shown in Graph 1.

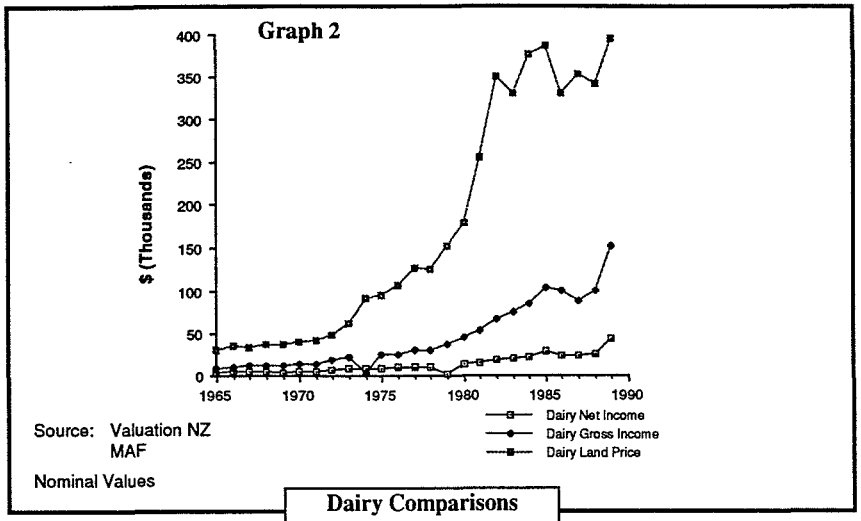


Land Price Comparisons CPI vs Indexes

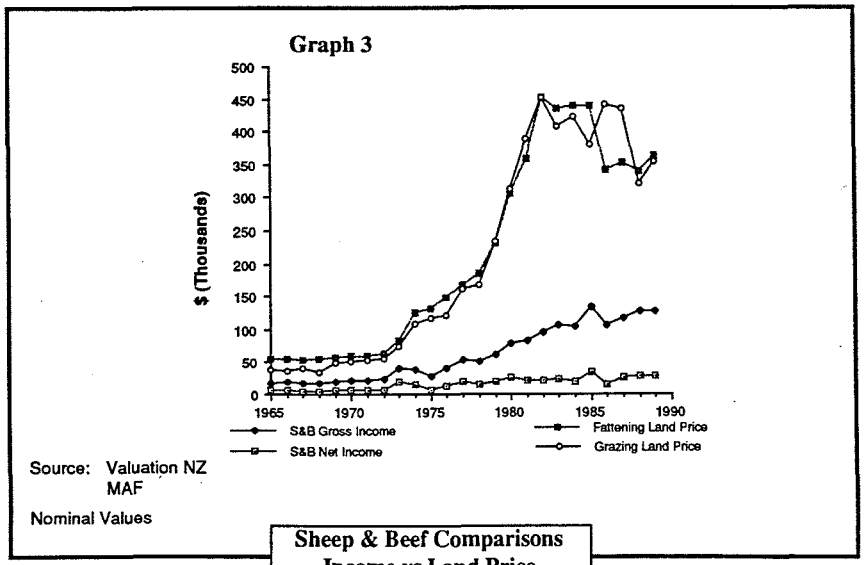
This shows land values tracking the CPI closely up until the early 80's, after which values have fallen (due to profitability factors) while inflation continued to climb. Regression analysis shows a very strong relationship from 1965 through to 1980 (R squared = 0.95 - 0.97), with a very weak relationship between 1980 to 1989 (R squared = 0.1 - 0.2).

2. Productive Value

The relationship between profitability and land prices over the last 25 years is shown in Graphs 2 and 3.



Dairy Comparisons
Income vs Land Price



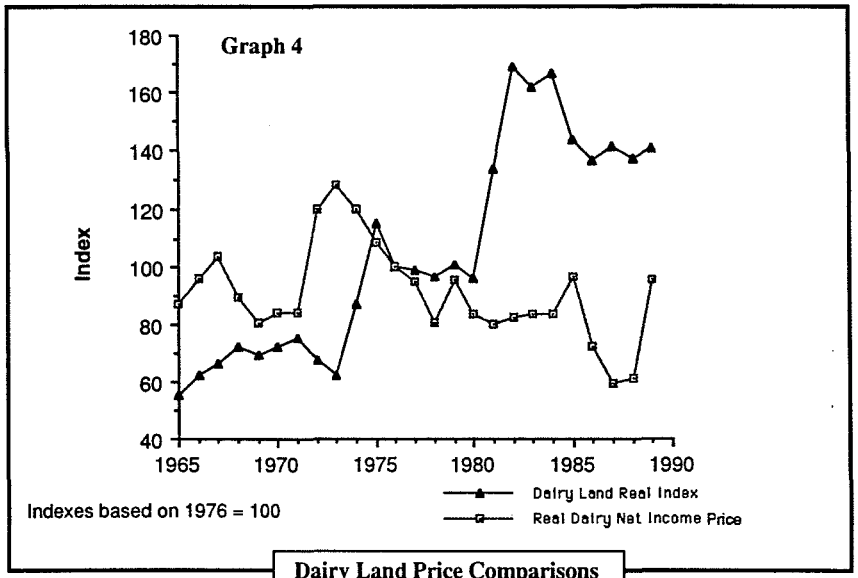
Sheep & Beef Comparisons
Income vs Land Price

These show the movement in land prices, average gross income, and average net income, in nominal values over the period 1965 - 1989. For the period 1965 through to 1980 there was again strong correlations between income and land prices, more so with gross income than nett income, especially for sheep and beef farms.

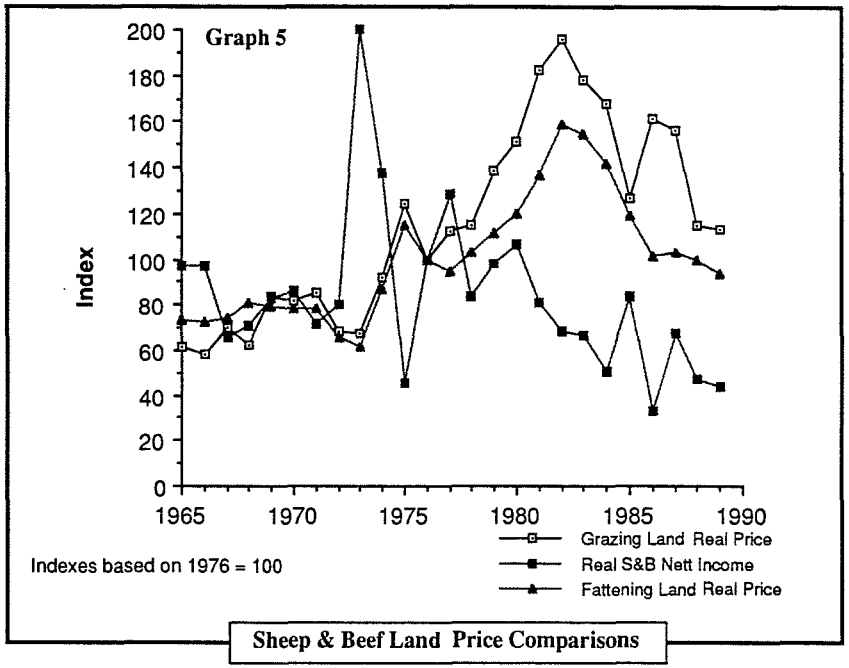
Dairy:	Gross Income:	R squared = 0.97
	Nett Income:	R squared = 0.93
S & B Fattening Land:	Gross Income:	R squared = 0.93
	Nett Income:	R squared = 0.72
S & B Grazing Land:	Gross Income:	R squared = 0.935
	Nett Income:	R squared = 0.73

Again this relationship deteriorated for the period 1980-1989, particularly for sheep and beef farms. The correlation for dairying dropped to an R squared value of 0.58 (Gross Income) and 0.48 (Nett Income) while that for the two sheep and beef farm types essentially dropped to zero.

Land and income values were then converted to real values for further comparison. This was done by deflating income streams by the CPI, and land values by an (implicit) pastoral product price index (achieved by dividing the value of pastoral products by the volume of products - R Johnson pers comm). The resulting relationships are shown in Graphs 4 and 5.



Dairy Land Price Comparisons



Sheep & Beef Land Price Comparisons

Analysis showed no real relationship at any stage, with R squared values around 0.0 to 0.2.

Lagging land values one year behind income gave no better correlation for either nominal or real values.

Comment

Prior to the early 1980's, a strong relationship existed between land market values, inflation, and farm profitability. Government assistance to agriculture in the late 70's and early 80's tended to be quickly capitalised into land prices. The removal of this assistance in the mid 80's saw farm incomes drop, particularly real incomes. The rural downturn, compounded in some regions by adverse climatic events, and combined with a general downturn in the New Zealand economy, saw land prices fall, despite continuing high inflation. It would appear that, at face value, farm profitability was the main factor in determining market values through this period.

However, the volume of sales also fell off markedly, dropping through 1985-1990 to around 20-50% of sales on an annual basis over the previous 10 years. Hence it could be argued that the "real" value of farmland has fallen less in recent years than is apparent at first indication.

And while it would appear that farm profitability is currently the major factor in determining improvements in farm income, the figures shown earlier in this report indicate that the relationship between productive value and market value have in fact widened.

Nevertheless, taking a longer term view, it could be hypothesised that:

(i) Land will retain its ability to act as a store of wealth

(ii) Assuming inflation remains at its currently low level, and in the absence of assistance to agriculture, land market values will move to be more closely aligned to productive values.

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Appendix IV

Rural Bank Interest Rates

Standard Interest Rates Applying to New Loans
Year ended March

	Settlement		Additional Land		Development		Stock and Plant		Refinance	
	Std	Concess	Std	Concess	Std	Concess	Std	Concess	Std	Concess
1970	5.0									
1971	5.0									
1972	7.0		5.50-7.0		5.5-7.0		5.5		7.0	
1973	7.0		5.5-7.0		5.5-7.0		5.5		7.0	
1974	7.0		5.5-7.0		5.5-7.0		5.5		7.0	
1975	7.0		5.5-7.0		5.5-7.0		5.5		7.0	
1976	7.5		7.5		7.5		6.5		8.5	
1977	7.5		7.5		7.5		6.5		8.5	
1978	8.5	7.5	8.5	7.5	8.5	6.0	7.5	6.0	9.5	
1979	8.5	7.5	8.5	7.5	8.5	6.0	7.5	6.0	9.5	
1980	9.0	7.5	9.0	7.5	9.0	6.0	9.0	6.0	11.0	
1981	9.0	7.5	9.0-11.0	7.5	9.0-11.0	7.5	9.0-11.0	7.5	11.0	
1982	9.0	7.5	9.0-11.0	7.5	9.0-11.0	7.5	9.0-11.0	7.5	11.0	
1983	9.0	7.5	9.0-11.0	7.5	9.0-11.0	7.5	9.0-11.0	7.5	11.0	
1984	7.5	7.5	7.5-9.5	7.5	7.5-9.5	7.5	7.5	7.5	7.5	
1985	12.5	12.5								
1986	21.0	12.5								
1987	19.0	17.5								
1988	18.0									
1989	17.5									
1990	14.9									
1991	14.5									

Source: 1970-1985 RBFC Annual Reports, various years. Usually found under the Finance section.
1986-1987 Answer to Parliamentary Written Question
1988 Estimated
1989-1991 Agri-fax data from "The New Zealand Farmer" (1989 rate is rate applying at July 1989)

Note: Up until 1986 the rates were fixed for the whole year. After 1986 rates fluctuated, so the rates shown indicate the rate applying at the end of the year.

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BARRIERS TO INCREASED EFFECTIVENESS OF AGRICULTURAL INSURANCE: THE U.S. EXPERIENCE

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Summary

Historically, 1 out of every 12 planted acres is not harvested in the United States (U.S.) due to adverse weather or other natural disasters. The U.S. government has a long history of providing disaster relief assistance to farmers. Currently, and throughout the 1980s, the U.S. Department of Agriculture provides adverse events assistance to producers through direct cash payments, subsidized loans and subsidized insurance.

Critics have charged that the various programmes are costly, duplicative, inequitable and unresponsive. Despite subsidized premiums and increased coverage, a substantial percentage of American farmers choose not to purchase agricultural insurance. As a result, government remains exposed to political appeals when natural hazards occur.

Risk management has become an increasingly important component of effective farm management in both New Zealand and the U.S. This paper will review the history, performance and limitations of the American agricultural insurance scheme and provide recommendations for national programmes of the future.

Key Words: **agricultural insurance, risk management, adverse events assistance**

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Introduction

Risk and uncertainty are a fact of life in any business, and production agriculture is generally perceived to be a risky endeavour. The major sources of risk in farming include unstable product prices and yields, unpredictable variations in input costs, technological change, shifting government policies and personal risks affecting the operator and family.

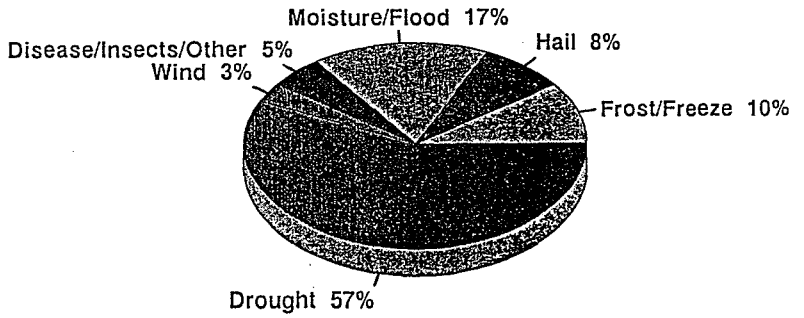
The factors which introduce uncertainty into crop and livestock production fall under two broad categories: meteorological and biological. Meteorological factors include excess or deficiency of rainfall and moisture, drought, flood, hail and windstorm. Biological factors include diseases and insects which are injurious to plants and animals. (see Figure 1).

Although the likelihood of severe crop losses due to natural hazards has been substantially reduced by technological advances, year-to-year variations in yields continue to pose a significant risk. In the U.S., causes of yield risk vary greatly by commodity and by region.

Like other business managers, farmers make decisions about risk and to what extent they want to protect their enterprise from adverse events beyond their control. *Risk management*, as used here, is defined broadly and encompasses both practices routinely utilized in seasonal production decisions and loss management strategies employed by producers to augment unusually low farm income due to shortfalls in production (Gabriel and Baker, 1980).

FIGURE 1

Major Causes of Crop Losses
All Crops, 1948 to 1991



Source: U. S. Department of Agriculture

To compete effectively for capital with other sectors of the economy, farmers must have available and adopt proven methods of risk management. They must minimize income instability that stems from yield and price uncertainties. Further, farmers operating in a framework of uncertainty may use various formal and informal strategies and precautions to eliminate or minimize its effects (Hornbaker and Hudson, 1987).

American and New Zealand producers have available a wide variety of production technologies from which to choose depending upon their production style or management strategies. If an uncertainty can be reduced to a risk, a formal strategy such as agricultural insurance could be employed to offset its effects on farm income.

In recent years, government-supported agricultural insurance has become one of several key risk management tools that have been utilized by U.S. producers to reduce the variability of farm income. Together with direct disaster assistance payments and low-interest loans, the total American taxpayer cost of adverse events assistance exceeded US$20 billion between 1983 and 1991. Such massive expenditures have heightened the need to reduce government exposure and increase the attractiveness of a comprehensive insurance-based adverse events assistance programme to farmers.

Background

History of Current Programme

The role of the U.S. government in attempting to help provide American agricultural producers with some measure of cushion against the economic instability inherent in their businesses has a long and consistent history.

As early as 1788, Benjamin Franklin suggested an office of insurance for farmers to cover damage inflicted by storms, blight, insects and the like. In 1880, tobacco growers and public officials in the State of Connecticut organized the first mutual company to offer agricultural insurance. In 1911, the State of North Dakota began operating a system of hail insurance. By 1920, more than a hundred crop-hail mutual companies had been organized in 13 States (Hazell *et al.*, 1986).

These early attempts at offering agricultural insurance were sporadic and short-lived. Little was known then about the frequency or the severity of hail damage within an area. By 1919, out of some 121 mutual hail insurance companies that had operated at one time or another, 80 had discontinued. However, the Great Depression of 1929 and the extreme drought of the 1930s brought agricultural insurance squarely before the public eye (Ray, 1967).

In 1936, President Franklin Theodore Roosevelt appointed a committee to make recommendations for legislation providing a plan of *all-risk* crop insurance. The committee's recommendations were largely adopted in the Federal Crop Insurance Act of 1938. This legislation established the Federal Crop Insurance Corporation (FCIC), a wholly-owned government corporation within the U.S. Department of Agriculture (USDA). The mandate of the FCIC was to promote the national welfare by improving the economic stability of agriculture through a sound and comprehensive system of crop insurance.

The original 1938 Act provided only for insurance on wheat, beginning with the 1939 crop. Insurance coverage on cotton began in 1942.

From 1939 to 1943 the type of insurance programme offered was referred to as *yield insurance*. The level of coverage was determined on an individual farm basis, using a historical average yield calculation. A farmer could insure either 50% or 75% of the derived average yield. Insurance contracts were annual contracts requiring the farmer to make application for protection each year. Indemnities paid farmers were in cash at the current value of the wheat or cotton due the producer, and wheat or cotton held in reserves was sold to provide the funds.

An insured was paid losses on the basis of one level of protection regardless of when the crop failed or what use was made of the land. Losses exceeded premiums on both wheat and cotton in each of the first 5 years of the programme. Due to this disappointing experience, the U.S. Congress passed legislation discontinuing the insurance programme in the 1944 crop year.

The programme was revived by Congress in 1945 with insurance on wheat, cotton and flax made generally available. In 1946, total indemnities for all insured crops exceeded premiums by US$28 million. Consequently, Congress passed legislation placing Federal crop insurance on a limited experimental basis in 1948, and directed the FCIC to develop a sounder basis for its all-risk insurance.

Between 1948 and 1969, insurance protection under FCIC increased from US$154 million to US$908 million. The number of crops eligible for insurance expanded to 24.

A 1970 task force appointed by the U.S. Secretary of Agriculture suggested a more personalized insurance programme. Further, the Agriculture and Consumer Protection Act of 1973 established a different but overlapping programme – the disaster payments programme (Dyson, 1988). This was designed to compensate a producer for prevented plantings and unusually low yields due to natural disasters, adverse weather and other conditions beyond his or her control.

The Federal Crop Insurance Act of 1980 signalled a new beginning for the nationwide agricultural insurance programme. The legislation authorized the involvement of private, nongovernmental organizations in all aspects of the crop insurance programme.

More specifically, the 1980 Act provided that the FCIC shall, to the maximum extent possible: (1) contract with private insurance companies; (2) encourage the sale of Federal crop insurance through licensed, private agents and brokers and provide the insurers the right to renew the insurance; and (3) establish and utilize committees or associations of producers in the development and implementation of programme modifications and improvements.

In summary, the 1980 legislation lifted many of the previous limitations that restricted the growth of the Federal crop insurance programme. The Act correctly recognized that an insurance programme can succeed only if the private insurance sector is broadly involved.

Since 1980, there has been a concerted effort from both the Executive and the Congressional branches of the U.S. government to convince farmers that Federal disaster relief programmes would not be reinstituted, and that government subsidized crop insurance would be the primary safety net for production yield shortfalls.

The Food Security Act of 1985 provided significant linkage between the Federal crop insurance programme and emergency disaster loan programmes beginning with 1987 crops. A shift in U.S. agricultural policy to replace the previous *ad hoc* disaster assistance programmes, that were fully taxpayer supported, with a self-help cost-sharing crop insurance programme was envisioned as having the potential of providing each producer with a variety of protection options while minimizing government costs.

However, in an effort to provide needed assistance to farmers affected by adverse events, who did not choose or were unable to purchase crop insurance, Congress approved legislation authorizing ad hoc disaster assistance in 1983, 1986, 1988 and 1989. As a result, USDA provides disaster assistance to farmers through direct cash payments, subsidized loans and subsidized insurance (U.S. Department of Agriculture, 1991a). Some of these programmes have remained in place after the need no longer exists. In recent years, the exponential expansion of disbursements under these various programmes has made the "band-aid" nature of the coverage obvious.

Conceptual Foundation

Objective analyses suggest that two factors influence the adequacy of protection under agricultural insurance and disaster programme payments. These are: (1) the size of the payment in comparison to a farmer's costs or losses; and (2) the effectiveness of the payment in stabilizing individual and aggregate farm income (U.S. General Accounting Office, 1989). Insurance industry analysts distinguish between disaster relief and insurance on the basis of the difference between normal or reasonable risks and abnormal or widespread risks of a catastrophic nature (Williams and Heins, 1989; Rejda, 1992).

Agricultural insurance can best be described as the application of commercial insurance principles to cover and provide compensation for the inherent risks involved in production agriculture (Kramer and Pope, 1982). It is a device whereby the losses suffered by some farmers are shared by all the producers exposed to the same risk. Such a scheme enables a farmer to substitute a regular annual premium cost for irregular losses.

Insurance coverage, as used here, is the amount of protection bought by the purchaser and the amount of liability assumed by the insurance company. In determining coverage, the acreage included in the insurance unit is critically important. An insurance unit is all or that portion of the insured's farm acreage that is taken into consideration when determining coverage and when settling claims for losses.

The coverage of a agricultural insurance policy typically depends on two factors -- the number of units of output the policy guarantees and the value the policy attaches to each unit of guaranteed output that is lost (Ray, 1967).

Premium rates are a function of expected losses and yield guarantee levels and can be expressed as:

$$\mathbf{R = (EL/Y_g)}$$

where **R** is the theoretical premium rate and **EL** is the expected losses, in insurable units, for a given yield guarantee level ($\mathbf{Y_g}$)(Mapp, 1988).

Theoretically, the annual premium rate per acre paid by farmers should be at least equal to the expected or average annual loss cost per acre to the insurance agency due to crop failure over a period of years (Lee and Djogo, 1984). The annual premium rate per acre usually varies directly with the degree of risk in the insured crop yield (Mapp, 1988).

Premium rates are used to calculate the cost of insurance coverage per acre. Thus, establishing fair and equitable rates that accurately reflect the risks associated with offering insurance is critical.

A basic principle of insurance is that pooling across regions and different commodities should improve the actuarial performance by reducing the variation in the overall losses (Hazell *et al.*, 1986). In addition, as participation increases there should be improvements in the actuarial soundness of the programme. Actuarially sound means that a proposed course of action over a period of time will result in total premiums earned being equal to total indemnities.

Indemnities are based upon the difference between the yield guarantee and the harvested yield, if any. Generally, the yield is averaged on all acres of the same insured crop on the farm. Yield variability is due to basically three sources: (1) purely random causes; (2) crop production hazards; and (3) differences in management and in production strategies among producers (Roberts *et al.*, 1989).

Adverse events vary in type, intensity and geographic extent from year to year. Over the last several years, 1 out of every 12 acres planted in the U.S. was not harvested due to adverse weather or other natural disasters (U.S. Department of Agriculture, 1991).

Insurance-type adverse events assistance programmes have considerable appeal because they are paid for by their direct beneficiaries. In theory, agricultural insurance is an efficient way of spreading risks among farmers, among regions, across sectors of the economy and over time (Ray, 1967).

Historically, a major role played by insurance programmes is the indemnification of risk-averse individuals who might be detrimentally affected by natural probabilistic phenomena (Greene and Trieschmann, 1988). The economic justification for agricultural insurance is that it can promote a more optimum use of resources by removing the price-distorting effect of risk (Barry and Fraser, 1976).

Expressed another way, insurance is a scheme by which the losses that fall heavily upon the few may be shared by many. The net benefit of insurance is represented by the difference between insurance payments, or indemnities, and premium costs (Rejda, 1992).

Three elements -- distributive, mutual aid and joint contributions to a premium fund -- form the core of insurance (Williams and Heins, 1989). The premium fund, it is hoped, will remain larger than the claims against it.

Agricultural insurance principles require a homogeneous insured population for an ideal insurance programme (Hazell *et al.*, 1986). The principal technique used to obtain maximum homogeneity is to stratify individuals into groups with similar risks. Regardless of the grouping method used, no group of individuals is perfectly homogeneous; both above -- and below -- average risks will exist within any insurance group. The challenge is to avoid insuring a greater-than-proportionate share of the below-average risks.

The general benefits of agricultural insurance to a producer depends on many factors, including a farmer's yield risk. Yield risk varies considerably among American producers, and farmers with higher yield variability are more prone to buy agricultural insurance (Mapp, 1988).

The efficacy of any agricultural insurance program is often reduced as a result of *moral hazard* and *adverse selection* (Roberts *et al.*, 1989). A moral hazard occurs when an individual can, after the insurance is purchased, influence the outcome of an event, thereby increasing the likelihood of receiving an indemnity payment.

Adverse selection occurs when an individual perceives that the risk of loss is smaller than the applicable premium implies, and thus chooses not to participate. Adverse selection encourages those with the highest risks to subscribe to the programme and discourages those with the lowest risks.

The remark, "There is no insurance without risk," is a generally accepted axiom. Exposure to risk is the prime prerequisite to the effective demand for insurance (Head and Horn, 1985). A producer's capacity to bear risk is generally based on her or his ability to maintain both financial liquidity and balance sheet equity necessary to continue operation (Hornbaker and Hudson, 1987).

The different categories of risks and uncertainties provide a background for understanding the major adverse event methods or approaches adopted in the U.S. These are: (1) insurance against losses on an actuarially sound basis; (2) insurance against losses with a subsidized premium; (3) guaranteed or subsidized loans to replace losses; and (4) grants which extend full or partial reimbursement to disaster victims.

Program Design and Structure

In 1922, Victor N. Valgren, an American pioneer in agricultural insurance, developed many of the principles of crop insurance which eventually became the basis for the U.S. Federal crop insurance programme. Currently, agricultural insurance is available in two forms: (1) limited peril insurance, including commercial hail and fire insurance; and (2) *multi-peril* or *all-risk* crop insurance.

Federal multi-peril insurance, as the name indicates, protects the crop against losses due to unavoidable causes, including drought, flood, hail, wind, frost, winterkill, hurricane, tornado, insect infestation, plant diseases and such other adverse events as may be determined by the FCIC.

Reinsured companies account for approximately 90% of all crop insurance business in the U.S., and share the risk of potential loss with the FCIC (Cason, 1992). The remaining 10% is sold by *master marketers*, who do not share the risk of potential loss.

Premiums are based on coverage levels -- the higher the production guarantee, the higher the premium. Production guarantees and premium levels are based on actuarial data collected and analyzed by FCIC.

A farmer may choose coverage at 50%, 65% or 75% of the farm's actual average yield over the previous 10 years. Coverage is limited by law to crop production expenses, not to exceed 75% of the normal crop value.

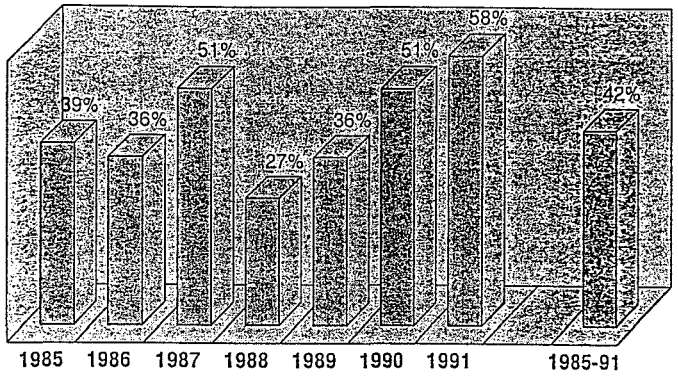
The deadline to apply for FCIC agricultural insurance is prior to the usual established planting date for a particular crop. Further, premiums become due at the end of the coverage period, whereas premiums for most other commercial insurance usually become due at the onset of coverage.

Indemnities are paid whenever the actual yield falls below the level of the yield guarantee. Indemnities are calculated by multiplying the amount of the yield loss by a predetermined price per insurable unit. The predetermined price is known as a *price election*, and is chosen by the farmer during the programme signup period. Price elections are set by the FCIC and based on commodity futures prices, supply and demand variables and other factors.

The cost of Federal crop insurance to producers is determined largely by the programme's loss experience (see Figure 2). Therefore, accurately adjusting claims for crop losses is vital not only to avoid squandering government funds but also to provide farmers with agricultural insurance at affordable rates (U.S. General Accounting Office, 1988).

FIGURE 2

Percent of Program Costs Paid By Farmers 1985-91 (Farmer premium as a percent of all costs)



Source: U.S. Federal Crop Insurance Corp.

Traditionally, insurable yield has been based on areas identified by FCIC according to similarities in soil type, production practices, yields and loss experience. The FCIC generally charged all producers within an area the same basic premium even though yields can vary significantly among farms in the same area.

In 1980, FCIC established a system for individualizing its insurance programme. An *individual yield coverage plan* was instituted allowing farmers to adjust production guarantees to reflect their average historical yield over a 10-year period. As a result, producers receive payments (indemnities) based on individual yield shortfall. For those years when individual producer records are unavailable, a county *transition yield* is used.

Participation Level

A producer may consider purchasing agricultural insurance for a variety of reasons: (1) regular predictable premiums can be substituted for irregular and unpredictable losses; (2) to increase the attractiveness of forward contracting and futures market hedging; (3) to facilitate additional borrowing and assure adequate income for meeting loan obligations; and (4) to ensure adequate income to make rental payments on rented acreage in the event of crop losses due to adverse events (Kramer and Pope, 1982; Lee and Djogo, 1984).

Moreover, U.S. farmers with high debt-to-asset ratios are more likely to subscribe to agricultural insurance (Mapp, 1988). This may reflect a realization that they are less able to absorb production risk themselves, or lenders' concerns about risk in loan repayment.

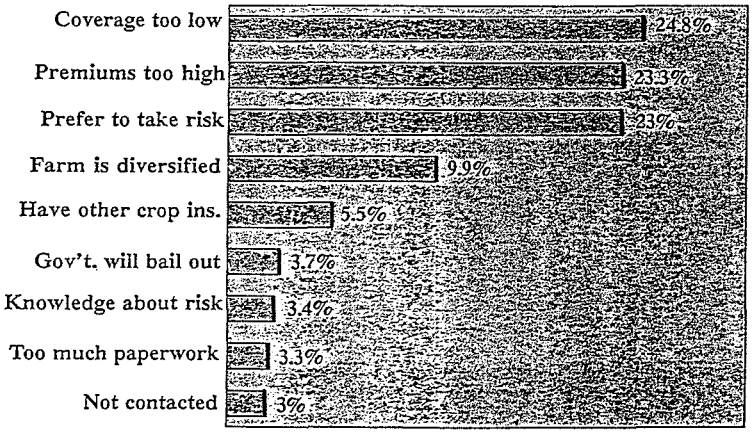
As noted previously, producers face more than a single choice of whether to insure or not. The level at which one insures is also important. The appropriate level of insurance coverage depends upon the operator's historical yield variability and initial debt (Hazell *et al.*, 1986). The more highly leveraged the farm business, the greater the anticipated net returns derived from agricultural insurance (Mapp, 1988).

The demand for agricultural insurance depends on an individual farmer's evaluation of the costs and benefits of insurance (Barry and Fraser, 1976). Previous studies have shown that participation in insurance programs is positively related to expected returns of the policy (Lee and Djogo, 1984).

Total participation varies widely among crops and regions of the country. Several reasons which have been proposed to help explain participation rate differences among States and crops include: (1) agent incentives and availability; (2) crop diversification; (3) crop use; (4) crop value; (5) length of time as insurable crop; (6) programme promotion and education efforts; (7) weather patterns; and (8) yield data availability (U.S. General Accounting Office, 1988; Commission for the Improvement of the Federal Crop Insurance Program, 1989). As indicated in Figure 3, two important reasons contributing to producer non-participation include perceived low coverage and high premium rates.

FIGURE 3

Percent Of Farmers Ranking The #1 Reason They Do Not Buy Federal Crop Insurance



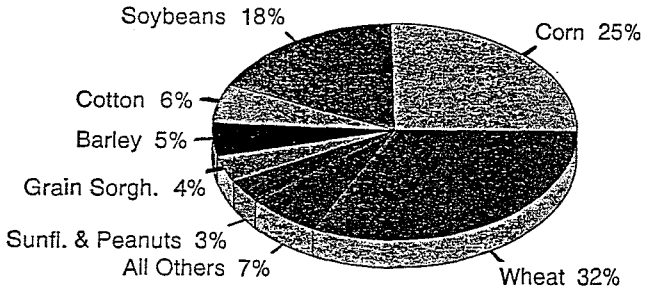
Source: U. S. Department of Agriculture

As shown in Figure 4, the major U.S. commodities with the highest number of acres, per commodity, insured are wheat, corn, soybeans, cotton, barley, grain sorghum, sunflowers and peanuts. These particular commodities comprise over 90% of all acres insured under the FCIC crop insurance programme (U.S. Department of Agriculture, 1991).

FIGURE 4

Share of Insurance By Acre

Crop Year 1991



Source: U. S. Department of Agriculture

In 1986, the programme covered 40 crops in approximately 3,000 counties. By 1987, the level of participation was only about one-half the 50% level envisioned by the Congress when the programme was expanded in 1980 (see Figure 5).

Presently, there are over 400 commodities produced commercially for food and fibre in the United States. In crop year 1991, FCIC and private sector insurance companies provided US$11.2 billion worth of crop insurance coverage on approximately 82.4 million acres covering some 51 crops in 3,026 counties (Cason, 1992).

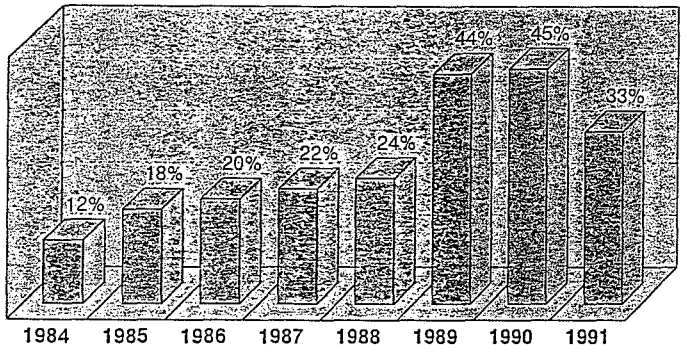
Over time, capital reserves for the insurance programme have fluctuated due to cycles of good and bad crop years and the amount of insurance sold. Premiums for crop years 1948-1976 exceeded indemnities by about US$20 million.

During the period 1981-1990, total indemnities paid out exceeded total collected premiums by US$2.5 billion. As a result, FCIC had to suspend insurance payments to farmers four times in 1985 and 1986.

In 1993, total collected premium is projected at US$912 million, increasing slightly from the 1992 estimated level of US$886 million -- reflecting higher premium rates (U.S. Department of Agriculture, 1992). Participation is projected to decline slightly, from 96 million insured acres in 1992 to 94 million in 1993 (Cason, 1992; U.S.

FIGURE 5

FCIC Participation Rates, All Crops Net Insured/Total Eligible Acres



Source: U.S. Federal Crop Insurance Corp.

Department of Agriculture, 1992). However, *loss ratios*, the ratio of indemnities to premium collected, are expected to improve slightly from 1.16 in 1991 (see Figure 6).

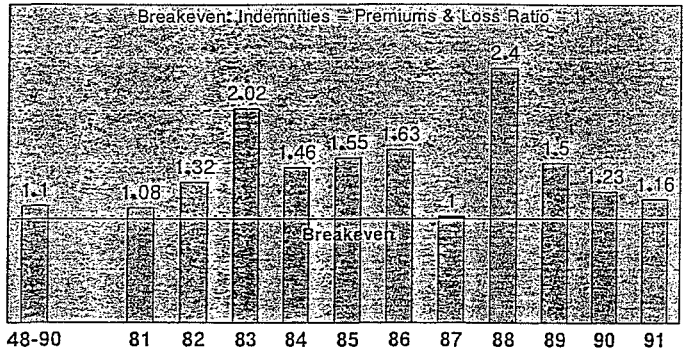
Strengths and Weaknesses of Current Program

In comparing the three generic forms of subsidized assistance available to America's farmers -- crop insurance, loans and direct payments -- insurance is arguably the most efficient and equitable method for providing nationwide disaster assistance. Insurance, over time, provides disaster victims with an analogous degree of assistance at comparable levels of cost, regardless of individual income level. In contrast, ad hoc legislative changes in the direct disaster payment scheme and subsidized loan program often occur in the wake of widespread adverse events. Such action creates inconsistencies and cries of inequity among producers in various parts of the U.S.

One of the major inhibitors to enrolment in the present crop insurance programme is the perception many farmers have that if there is a widespread adverse event, Congress will legislate ad hoc disaster assistance and all affected producers will receive government payments to compensate for their losses. Consequently, ad hoc legislation obscures the division of risk between the government and the producer and undermines the FCIC crop insurance programme (U.S. General Accounting Office, 1989).

FIGURE 6

FCIC Loss Ratio (Indemnities/Premiums) All Crops, 1948-91



Source: U.S. Federal Crop Insurance Corp.

Since 1984, the costs incurred by the Federal government in providing disaster assistance programmes have increased over US$5 billion, averaging approximately US$565 million per year (see Figure 7). Such a tremendous increase in USDA budgetary exposure has heightened the clamour for change. Further, numerous critics have charged that the various adverse event relief programmes currently implemented are costly, duplicative, inequitable and unresponsive.

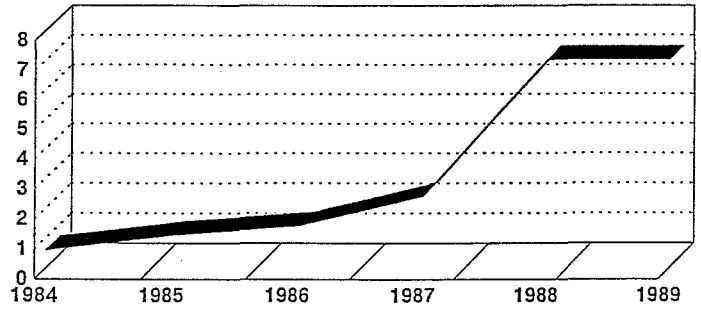
By helping to insure a minimum level of output, agricultural insurance can facilitate access to credit, capital formation and investment decisions. In addition, many insurers use agricultural insurance to safeguard continuance of their working capital borrowings. To the extent that these benefits are realized, both farmers and other rural residents should benefit from the programme. However, despite increased geographic and crop coverage and subsidized premiums, participation has increased at a rate less than projected.

The primary reasons for the failed efforts of private insurance companies in providing all-risk agricultural insurance include: (1) too broad a coverage of risks; (2) insufficient data for sound actuarial appraisal; (3) group coverage inadequately tailored to the risks confronting individual farmers; and (4) contracts written too late in the growing season (Commission for the Improvement of the Federal Crop Insurance Program, 1989). Even though premiums may equal losses over time, the year to year loss variability makes it difficult for private insurance companies to cover such risks because of the magnitude of the required premium fund reserves. Consequently, private firms have generally restricted their crop insurance coverage to hail, fire and lightning.

FIGURE 7

U. S. Government Costs For Agriculture Disaster Assistance

US$ In Billions



Source: U. S. Department of Agriculture

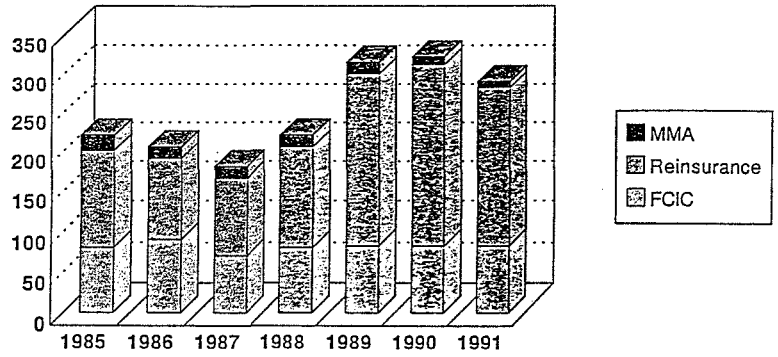
Previous studies have shown, among other things, significant producer dissatisfaction with the insurance package, particularly the premium rates and coverage levels offered (Roberts *et al.*, 1989). In addition, producers and insurance agents are often discouraged by the complexity of the programme and the frequent programme changes.

Further, administrative costs can be quite high relative to the benefits producers receive in terms of risk reduction (see Figure 8). Also, since crop insurance usually addresses only yield risks, its contribution to income stability may be limited in some cases where yield variations are not the predominant factor in income fluctuations (Kramer and Pope, 1982; Mapp, 1988). Moreover, clearly distinguishing crop losses due to natural

FIGURE 8

Administrative Costs Associated With Federal Crop Insurance Program

US$ In Millions



Source: U.S. Federal Crop Insurance Corp.

causes from those due to poor farm management can be administratively problematic (Hazell *et al.*, 1986).

As mentioned previously, farmer participation has been greater in the high-risk areas of the U.S. Failure to attract a sufficiently large number of farmers nationwide has made it increasingly difficult to operate an actuarially sound broad-based crop insurance programme.

Needed Program Improvements

What is an "adequate level" of protection? This is probably one of the most difficult questions for policy makers and programme administrators to address.

Some minimum level of participation is necessary for a nationwide agricultural insurance scheme to effectively replace current emergency disaster assistance programmes in the United States. Many observers agree that the greatest inhibitor to participation in the U.S. crop insurance programme is the preconceived notion by producers that if there is a widespread adverse event, all farmers will receive emergency disaster assistance, making a crop insurance purchase a less attractive investment.

In addition, a paucity of farm yield data has made it difficult to tailor a crop insurance programme to each individual producer. Many farmers do not have sufficient records upon which to base a yield guarantee.

Individual protection requires an elaborate delivery system to make accurate assessments regarding the potential of each individual and to assess losses when a farmer has a claim. Because there are two delivery systems currently offering FCIC insurance policies, differences can exist in procedures used in selling insurance and adjusting losses. Achieving uniformity, to the maximum extent possible, in the policies and procedures of both delivery systems should greatly increase the efficiency of marketing and loss adjusting.

Several U.S. policymakers have suggested that the complete elimination of direct disaster assistance payments, coupled with a crop insurance requirement for all participants in U.S. farm programmes, is the most effective way to ensure a viable agricultural insurance scheme. However, simultaneous achievement of both high participation in any new insurance-based programme and the complete termination of the current ad hoc disaster assistance programmes has proved politically difficult.

Can a Better Safety Net Be Built?

Congress created the *Commission for the Improvement of the Federal Crop Insurance Program* in 1988 to provide a thorough review of the current nationwide crop insurance programme and to develop recommendations for needed changes. The principal objective of the Commission in developing its recommendations was to address the specific concerns of agricultural producers. Thus, in 1989, the Commission included in its final report a number of recommendations aimed specifically at increasing the programme's responsiveness to producer needs.

As indicated in the Commission's final report, the difficulties involved in designing a scheme which will avoid problems of moral hazard and adverse selection while maintaining low administrative costs and sensible risk reduction are very complex. Nonetheless, one should rely on three basic principles -- equity, efficiency and effectiveness -- in developing criteria for determining the best way to provide adverse events protection (Commission for the Improvement of the Federal Crop Insurance Program, 1989).

Under an equitable programme, disaster victims should be treated consistently over time. An efficient programme requires highly trained sales agents, qualified claims adjusters and quality control programmes to assure properly administered sales, services and claim activities while minimizing costs. An effective scheme achieves programme goals and objectives.

Moreover, a successful insurance programme must be projected over many years, sufficient to predict rates based upon a predetermined actuarial base (Williams and Heins, 1989). The success of a programme can be seriously jeopardized by continually disturbing insurers with changes in rates, rules, contracts and coverage.

The recent interest of other countries in agricultural insurance derives from common problems and objectives but with varying orientations (Roberts *et al.*, 1989). In common, they seek to provide protection to producers from catastrophic losses caused by the perils of nature, using the vehicle of insurance. Catastrophic risk protection for farmers requires balancing reasonable governmental budget exposure with the level and stability of protection offered.

The usefulness of producer participation as a measure of programme success depends upon how realistically the participation goals are established. Moreover, an excessive preoccupation with producer participation goals could present an inclination to compromise actuarial soundness for saleability.

To help ensure that premium rates and insurance coverages are set at levels commensurate with the likelihood of insured losses, rates and coverages need to be validated using current crop yield and loss data. Also, to be attractive and fair to producers, the rates and coverages offered to them need to be commensurate with the potential risks involved.

Interestingly, raising premium rates can often lead to reduced farmer participation, and the risk pool can become concentrated with producers who operate higher-risk operations (Hazell *et al.*, 1986). Therefore, the premium calculation should be reviewed from time to time according to the accumulating statistical data and experiences which help increase the accuracy of the probability calculations for various events.

To minimize the likelihood of excessive claims in a single year, a crop insurer may diversify the liability among several crops and geographic areas. Another device, often

used by smaller insurance firms, is to reinsure with other companies, thus diffusing the burden of liability (MacCrimmon and Wehrung, 1986).

One of the standard approaches to the problem of adverse selection is to define classes of growers on the basis of their yield variability. This can help improve the precision of mapping between premium rates and the risks of production.

Further Research

Before the perfect programme can be designed, certain fundamental questions require further examination. For example, what are the factors that enter into a producer's decisionmaking process in the face of uncertain adverse events? What is the specific nature of a farmer's objectives regarding financial security, risk-taking and profits? And how satisfactory are the various production practices and management strategies that a producer has at her or his disposal?

Enhanced research efforts need to explore the potential impacts on producers, insurance companies and the public good of the shift to individual yield histories for alternative crops and regions of the country. In addition, research should be pursued on the interactions between the agricultural insurance decision and other production, marketing and financial risk management strategies. Efforts should also be encouraged to exploit the potential of weather-based computer modelling in agricultural insurance.

Concluding Remarks

As previously discussed, there are a number of options for assuring that production agriculture has adequate protection against losses resulting from natural adverse events. Government contributions have taken several forms in the U.S. including the subsidization of premiums, allowances for administration costs and subsidized reinsurance against catastrophic disasters.

If an insurance-based programme is to be utilised in a policy context, the nature of the protection desired must be defined. In other words, should there be concerns about variations within the year or variations between years? Will comprehensive or partial protection be provided? Will protection be provided for the individual or the group? The answer to these questions will be important in determining the appropriate policy option to pursue.

As countries such as New Zealand and the U.S. seek to reduce and eliminate governmental expenditures on farm support programmes, and continue to expand into international markets, effective risk management at the producer level will be increasingly important. Given the alternatives of agricultural insurance and direct disaster relief payments, insurance is an attractive choice, as it can be stable, predictable in its presence and distributed by need rather than political whim.

Furthermore, agricultural insurance possesses at least two features that make it particularly attractive to U.S. policymakers. First, insurance programmes are generally designed to be countercyclical. Theoretically, agricultural insurance is a net cash drain in favourable years and a source of producer capital in devastating ones. A second feature of insurance that many find appealing is its potential to link the cost of protection to management decisions.

Classically, insurance is not intended as a device by which the insured may profit. As such, agricultural insurance is certainly not a total risk-reducing panacea.

However, by spreading risks among many farmers, through diverse regions, across sectors of the economy and over time, agricultural insurance may provide a more efficient alternative to many traditional risk-sharing arrangements.

Crucial steps to reduce the overall cost of agricultural insurance include improvements in actuarial practices, enhanced management of investment portfolios, access to reinsurance, improved product marketing and reductions in administrative expenditures. The most equitable insurance contract for both the insured and the insurer is one that offers a reasonable amount of coverage for a fair premium.

The long-run financial implications of agricultural insurance at the firm level are dependent on a number of factors. Nonetheless, in view of the significant economic and structural challenges facing the food systems of many developed countries and the general level of dissatisfaction that seems to exist regarding current farm policy worldwide, insurance-based adverse events relief programmes deserve greater consideration by policymakers.

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THE MEASUREMENT OF RISK IN AGRICULTURAL INVESTMENT: THE CASE OF IRRIGATION

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ABSTRACT

In this paper we examine risk in the context of project analysis. We assume that uncertainty prevails in the estimation of all parameters in an investment analysis. We maintain that the analyst should be aware of these uncertainties in his/her calculations and should pass them on to decision makers. We therefore assess available techniques for incorporating risk in project analysis and demonstrate our findings by reference to the Morven-Glenavy Irrigation Scheme. We offer risk adjusted estimates of the net present value, a discussion of risk-adjusted discount rates, and an estimate of the "value" of risk protection given by the increased assurance that irrigation provides. In the past, this value of risk reduction has been passed to the irrigators without further payment.

INTRODUCTION

In this paper we examine risk in the context of project analysis. The first section discusses relevant risk concepts. The next section then backgrounds risk measurement in agricultural projects and irrigation projects in particular.

The Capital Asset Pricing Model is used to estimate a weighted average cost of capital for agriculture in terms of 1988 dollar values and conditions. The next section summarises the analytical history of the Morven-Glenavy Irrigation Scheme from its inception to its negotiated sale by the Labour Government to the landowners. To illustrate the application of the analytical risk evaluation program the marginal value of the scheme assets - following the approach used by MAF and Treasury - is estimated.

Finally, an application of option pricing theory is explored in the context of the production risk. Dryland farming has been shown to be more riskier than irrigated farming and in moving from dryland to irrigation, the reduction in risk implies a benefit to the irrigator that is not recognised or measured in project analysis.

RISK CONCEPTS

Risk and uncertainty have separately defined meanings, however in current practice, the distinction has become less important. Risk in a pure sense, refers to variability of outcomes that can be statistically measured. Uncertainty in a pure sense, refers to variability of outcomes that are totally unmeasurable. Most items of variability would be a combination of both risk and uncertainty, and simply referred to as risk.

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In mathematical modelling or programming, the term stochastic is used to describe risk.

Gough (1988) references Starr et al (1976) where they define four measures of future risk:

1 Real risk: Determined eventually by future circumstances when they develop fully.

2 Statistical risk: Determined by currently available data, typically measured actuarily.

3 Predicted risk: Predicted analytically from system models structured from historical data.

4 Perceived risk: Seen intuitively by individuals.'

In an ex-ante sense, real risk can never be evaluated. Statistical and predicted risks are often called objective estimates, but subjective elements may be present due to lack of data and assumptions in the estimation process. Perceived risks are referred to as subjective estimates, but there will be elements of objectivity.

Risk estimates may be able to be determined statistically, but at greatly increasing costs, in order to have an increasingly objective basis. Subjective risk estimation techniques have been developed for decision making theory, in particular. The degree of risk can be explained in terms of the variance associated with a range of possible outcomes in the normal Markowitz trade-off sense.

In any model of an investment project the objective function might be net present value, internal rate of return, or some income level. Such analysis requires the specification of a probability distribution for each stochastic variable. While there are a number of types of distributions, MAF has always used the triangular distribution. This requires the specification of three points, a low, a modal and a high. Technically, the low and high should reflect the 1% and 99% confidence limit.

In combining a number of stochastic variables, cognisance must be made about the relationship between them, that is, the cross-correlation coefficients must be specified. For intertemporal analysis, the relationships within each stochastic variable - the autocorrelation coefficient - may be relevant. However, the autocorrelations for agricultural product prices series have always been statistically insignificant, and therefore have been ignored.

Methods for effectively handling a number of stochastic variables in a modelling exercise require at least four criteria:

1 Judgement is applied to the underlying assumptions.

2 Interaction between stochastic variables is taken into account.

3 There is an overall indicator of the variability of the final outcome.

4 There is a consistent analytical framework.

These factors are taken into account in the methods described below.

BACKGROUND TO RISK MEASUREMENT

For many years, economic analysis of government funded, or partially funded, agricultural projects have been carried out at the most likely values of the main productive and price parameters. Many analysts believed that they were estimating with the true mean and that the estimated result parameters were estimated with certainty. When questions of uncertainty are raised on the data that is used and the methods that are employed these conclusions must be seriously modified. Only in the case of normal distributions can the most likely values be ascribed as having mean values. It therefore follows that the nature of the data distributions must be specified before any such analysis takes place. To be fair, additional sensitivity analyses have been included in many studies. But such analyses are a very rudimentary form of risk measurement.

For some years models have been available to assess the uncertainty impacts caused by estimated input data. These require the analyst to specify the uncertainty range of the input parameters by formal or informal techniques. With appropriate specification of this range, the analyst can proceed to identify the mean, the mode and the standard deviation of the data. MAF's analytical risk evaluation program (Bell 1977) has been made more user friendly and converted to a microcomputer environment and is now called ANWA (McKenzie *et al* 1991). With the widespread use of LOTUS 1-2-3, the @RISK add-on provides a simulation model alternative to ANWA.

The Capital Asset Pricing Model (CAPM) adds another dimension to the total risk facing individual firms, by partitioning risk into systematic and non-systematic components. (Sometimes referred to as non-diversifiable and diversifiable risks, respectively.) Uncertainty associated with market conditions, macroeconomic trends and climate (systematic risk) is largely beyond a farmer's control and has to be accommodated through risk management strategies. Non-systematic risk is what is left and mainly relates to on-farm organisational matters under the farmer's control. The CAPM provides a method of making this distinction and hence isolating the on-farm factors. The CAPM can also provide an estimate of the weighted average cost of capital (WACC) appropriate to the individual firm and industry.

The CAPM estimates the premium which should be added to a risk-free rate of interest to allow for the riskiness (uncertainty) usually of an industry in which the investor is interested. There is therefore a need to explore the discount rate in investment analysis as a tool to find the risk-adjusted discounting factor appropriate to a given investment. Finance theory favours this approach, which specifies different beta coefficients and therefore WACCs, for different risk rated projects. From an economic perspective, project related risk is dealt with in the cost and benefit flows and not in the discount rate. In finance theory, this is often referred to as a certainty equivalents approach (Brealey and Myers 1991; p202).

There is a further implication of the discount rate choice in whether it should have been used for public schemes like irrigation when the Government was the developer and the borrower. In spite of being able to borrow at the risk-free rate, the Government's investment decisions have tended to be guided by an opportunity cost of capital argument in the use of the 10% real Public Sector Discount Rate. The irrigator's themselves, of course, made their own private decisions of whether to invest in irrigation and this would also be influenced by appropriate risk factors. Therefore the ranking of alternative investments according to the uncertainty about their outcomes can also be an important objective of decision making.

Irrigation is introduced into the discussion to bring out the particular fact that it changes the risk status of an enterprise. In technical terms an irrigation opportunity increases the yield factor and decreases the uncertainty factor. This objective has been implicit in the New Zealand irrigation movement for many years but does not ever appear to have been explicitly recognised in any of the many planning and review documents associated with these initiatives. In effect, the reduction in uncertainty over crop and pasture yields is passed as a non-priced benefit to the farmers who elect to come onto a scheme.

The then Ministry of Works required a majority decision by landowners within a proposed irrigation area as part of project planning. The increased certainty was an argument no doubt used to get farmers to join the scheme. However the state subsidised the construction work and many on-farm works and charged the irrigators a fee for water used. Farmers never paid the full historic cost of the water the state provided. Thus not only was the water under-priced but the value created by increased certainty of yields overlooked. One of the aims of this paper is to value this increased certainty. In effect, the "value" of this decreased uncertainty passed into land values along with an increment due to the under pricing of water.

A technique which has been used to value increased certainty in other applications is option pricing theory (Seed and Anderson 1991, Bardsley and Cushin 1990). In simple terms, the irrigator problem can be seen as a situation where a definite benefit to the farmer is created. Although there is no pricing mechanism for it, it can be identified by assessing what the irrigator would pay for the protection if he had to buy it from an insurance company. We suggest option pricing theory can be used to value explicitly this reduction in risk. Adding this value to the discounted cash flow results for a project is an approach increasingly being advocated in the financial economic and natural resource economic literature. For a survey of relevant literature see Seed (1992). An illustration of this approach is described later in the paper.

WEIGHTED AVERAGE COST OF CAPITAL USING CAPM FOR MORVEN GLENAVY

Systematic risk is that risk associated with general fluctuations in the economy. The CAPM compares the return on capital in an individual firm with an index representing a portfolio of returns in a similar industry or in all industries. An important property of such an index is that diversification opportunities for the individual firm are ruled out by assuming the average for the industry is only fluctuating with the general economy. The beta coefficient measures the common variation between the individual and the group and this is the systematic risk component. The regression also gives information on unexplained variation or risk and hence indicates the so-called diversification risk. The beta coefficient, in effect, measures the amplitude of the fluctuation in the individual firm's return compared with the group average.

It is also possible to develop beta coefficients for industry groups so that industries can be ranked by the magnitude of their systematic risk component. It would then be possible to develop enterprise, firm level, and industry level risk rankings for investment analysis. The CAPM does not always give unambiguous results and alternative methods of risk assessment should also be sought. The following methodology was employed:

Pre-tax WACC in nominal terms, Wn, and in real terms, Wr, are defined as follows:

$$Wn = d*Rd + (1-d)*Re$$
$$Wn = d*[Rf + (Rd - Rf)] + (1-d) * [Rf + b * (Rm - Rf)]$$
$$Wr = [(1 + Wn) / (1+I)]$$

Where:

d	=	debt proportion of total assets
Rf	=	risk-free interest rate
Rd	=	interest rate on debt
Re	=	return on equity
b	=	beta coefficient of systematic risk
(Rm - Rf)	=	market risk premium (MRP)
I	=	inflation rate expectation

The following assumptions are used to estimate Wn and Wr:

d = 0.39 — This is based on the NZ Meat and Wool Boards Economic Service's 1988/89 survey results for their South Island Finishing-Breeding Class.

Rf = 13.2% — This is the average yield on Government five year Bonds for 1988/89.

Rd = 17.28% — This is the average mortgage interest rate for 1988/89 compiled by CS First Boston Pacific from Reserve Bank data.

b = 0.75 — Agriculture Sector: CS First Boston Pacific's estimate for the agricultural sector. This was adjusted from an ordinary least squares result of 0.49.

b = 0.53 — Farm Class: Tentative results from current MAF Policy work indicates a statistically significant beta for the South Island Finishing-Breeding Class of 0.53, when based on a stock market index of agriculturally related corporations (Narayan and Johnson 1992a).

(Rm-Rf) = 8% — CS First Boston Pacific's estimate from a data series from 1969 indicates a range from seven to nine percent. The mid range value is consistent with an international average value.

I = 6.35% — The Reserve Bank's June 1988 survey of annual CPI expectation for March 1989 and March 1990 were 6.6% and 5.6%, respectively. A figure of 6.35% is deduced for annual inflation at June 1989.

The results are set out in table 1 with a sensitivity range of the market risk premiums and with beta at 0.75 and 0.53.

Table 1: Weighted average costs of capital estimates in nominal and real terms for 1988/89.

			Wn (%)	Wr (%)
b	=	0.75		
MRP	=	7%	17.4	10.4
	=	8%	18.6	11.5
	=	9%	19.1	12.0
b	=	0.53		
MRP	=	7%	17.0	10.0
	=	8%	17.4	10.4
	=	9%	17.8	10.7

b = beta coefficient *MRP = market risk premium*

The results in table 1 suggest discount rates of between 10% and 12% for cash flow analysis relating to the valuation of irrigation assets. The Government's 1988/89 asset valuation process used a post-tax rate of 7.5% which corresponded to a pre-tax rate of about 11%.

MORVEN-GLENAVY IRRIGATION SCHEME

The Morven-Glenavy Irrigation Scheme is on the north bank of the Waitaki River with an irrigable area of 10,458 ha, of which 75% was developed for irrigation by 1988.

An ex-ante economic analysis of the scheme was carried out in 1968 (Watkins 1968) and construction started in 1971 with the first water available for the 1974/75 season. The net present value at 6% discount rate was about $75,000, assuming a 15 year development period. Sensitivity analyses were carried out with respect to product prices and development periods.

In 1986, an ex-post analysis was carried out, but never fully written up. The results in terms of December 1985 dollar values are as follows:

Net Present Value at 10%	=	-$12.2 m
Net Present Value at 6%	=	-$3.6 m
Internal rate of return	=	5.4%

The ex-ante results expressed in December 1985 dollar values was:

Net present value at 6%	=	$0.66 m

The significant difference between the two analyses was in the off-farm construction cost that rose from $8.96 million to $14.33 million. The on-farm capital cost - excluding livestock - incurred over the development period was $17.59 million or 55% of the total capital expenditure (December 1985 dollar values).

As part of the Labour Government's asset divestment process, irrigation assets were to be valued and sold to land owner participants (MAF 1992). The Morven-Glenavy Scheme was combined with a neighbouring and much smaller Redcliffs scheme and sold as one entity for $0.55 million. Effectively, the Redcliffs scheme had a zero asset value. Although the agreement for sale was signed on 31 October 1989, the financial settlement is yet to be completed.

In 1988, a valuation model was jointly developed by MAF and Treasury. Essentially, the model treated all past costs by both the Crown and irrigators as sunk and assessed the net benefit of continuing with, and further development of, irrigation compared to an immediate reversion to dryland farming. The result, in present value terms, for each scheme became the upper limit of the asset price in the negotiations between the Crown and irrigator representatives.

A series of downward adjustments were made. The first of these was to reflect the marginal value of irrigation to the predominant sheep farming land use. Water can only be sold for one price, irrespective of land use applications. Further adjustments were made; for example, past investment also created on-farm irrigation assets and historical debt was an issue. Given the distribution of off and on-farm capital expenditure, the Government was only selling a little less than half of the asset value derived by the valuation model.

The offers finally accepted by the Government for all schemes were well below the Treasury's estimates derived from the valuation process. The financial risk exposure as a consequence of the tight monetary policy pursued by the Reserve Bank and the downturn in farmgate prices at the time, would have had a large influence on the irrigators negotiating stance (Crump pers. comm).

The initial survey data used in the valuation process for Morven-Glenavy was simplified for analysis using ANWA. The 1988 level of irrigation development and land use is held constant and the potential livestock carrying capacities are reduced to the actuals indicated by the 1986 ex-post study. Land uses are sheep (4,650 ha), beef (150 ha), deer (300 ha) dairy (1,550 ha) and cropping (1,200 ha). A project life of 40 years is assumed.

The key stochastic variables identified are prices of wool, lamb and milkfat, and yield coefficients for wool and lamb numbers under dryland and irrigation. The standard deviations for these variables are obtained from MAF's medium term product price forecasts (Forbes 1988) and research into irrigation risk reduction for the scheme (SriRamaratnam and Arthur-Worsop 1990). The research showed that variability of net returns for dryland sheep farming was twice that of irrigation and for wheat production, irrigation reduced variability by more than twice that of dryland.

Two sets of results are calculated and set out in table 2. The first involves all land uses and the second assumes a sheep farm land use for the whole irrigated area.

Table 2: Valuation of irrigation assets using ANWA

Discount rates	**10%**	**12%**
All land uses	**($ million)**	
Net present value	15.58	12.79
Standard deviation	1.28	1.17
95 percentile		
- from	13.07	10.50
- to	18.10	15.08
Coefficient of variation	0.08	0.09
Sheep land use		
Net present value	9.72	8.00
Standard deviation	1.68	1.52
95 percentiles		
- from	6.43	5.01
- to	13.01	10.99
Coefficient to variation	0.17	0.19

The increase in variability between the two sets of results is because of the concentration of stochastic variables in sheep land use.

To gain a fairer comparison of the ANWA results with the sale of off-farm irrigation asset for $0.55 million, the distribution between off and on-farm depreciated capital expenditure, in December 1987 dollar terms, is calculated. Using data from the ex-post study and asset wastage rates determined by Narayan and Johnson (1992b; table 4) the distribution between off and on-farm depreciated capital expenditure is found to be 44.36% and 55.64%. Applying these to the sheep land use results of table 2, gives a range between $2.22 million (lower percentile, 12% discount rate) and $5.77 million (upper percentile, 10% discount rate), and means of $3.55 million (12% discount rate) and $4.31 million (10% discount rate).

Recent research by SriRamaratnam and Arthur-Worsop (1990) shows that production systems on irrigated land have significantly lower variability, in terms of net income than those on dryland. The coefficients of variation for dryland sheep and wheat enterprises were one point nine and two point three times as high, respectively, as that for irrigated farms. This suggests that irrigation significantly reduces the variability of pastoral and arable production and, therefore, production risk.

Given that irrigation reduces risk, one way to approach the problem is to think about the value of risk reduction in the context of agricultural livestock, or crop, insurance. That is, if the drought risk could be insured against, how much more, than farmers on irrigated land, would dryland farmers have to pay and - more importantly - what would be the difference in premiums between the two farm types. We suggest that the differences in notional premium would provide an indirect estimate of the value of the reduction in risk.

With most crop insurance contracts, farmers pay a premium to the insurance company which is assuming the risk. For example, Pyne, Gould, and Guiness offer a "combined perils" cover for cereals which covers the risk of fire, windstorm, hail, flood and snow. The charge for this sort of cover is 2.3 per cent, or $23 per $1,000 insured. Therefore to cover a 5 tonne per ha crop of wheat, assuming a wheat price of $250, a farmer would pay $28.75 per ha (5 x $250 x 0.023). As one would expect, the premium for riskier crops is higher than that for less risky crops. Pyne, Gould, and Guiness also offer stock insurance for "loss of use by accident" for which premiums range from 4.7 per cent to 14 per cent of the value of the animal insured.

The commercial production insurance contracts discussed above do not cover drought. The reason for this is largely because there is no way the company offering the insurance could manage the risk from an adverse event, such as a drought, which is likely to affect all of the insurance company's clients in one geographical area at once. Accidents, and other risks normally assumed by insurance companies, are usually random events. Therefore, if the insurance company holds a diversified portfolio of risks it is unlikely that all clients will make a claim at the same time. However, a drought will affect virtually all of the potential claimants. When one farmer is suffering from drought it is highly likely another client in the same geographical locality will also be affected adversely. This is similar to the problem facing companies which offer forms of earthquake insurance.

One of the benefits of irrigation which is often overlooked and rarely, if ever, quantified is the value of the reduced risk of the farm production system. One way to do this is to ask: "If irrigated and dryland farmers could pay someone to remove drought risk from their production system how much would the insurer charge?" That is, if there was such a thing as drought insurance how much more would farmers have to pay to insure dryland production systems compared to irrigated production systems?

Insuring against production risk is similar to insuring against price risk. Previous studies by Seed and Anderson (1991) and Bardsley and Cushin (1990) have estimated the value of price support policies by estimating how much farmers would have to pay to guarantee the minimum price offered by the programme. The extension to guaranteeing production, rather than some minimum price, is a relatively straight forward one. Any form of guarantee has similar characteristics to a put option. A put option gives holders the right but not the obligation to sell a specified asset for a specified period of time at a specified price. Minimum price schemes also grant producers the right, but not the obligation, to sell their production, to the agency

administering the scheme, at the minimum price prevailing during the current season. That is, the guarantee scheme, or "option", is worth something if the market price is below the minimum price. As demonstrated by the above two studies, the value of minimum price schemes may be substantial even when the market price of the commodity is above the minimum price. That is, the guarantee, in itself, has some value to the farmers. Likewise with forms of production insurance, the insurance, in itself, is worth something even through the farmer may not make a claim. That is, having the guarantee reduces risk and that risk reduction has a positive value. If we extend the insurance analogy to irrigation, participating in the irrigation scheme guarantees some minimum level of production. That is, downside risk is reduced.

To demonstrate the magnitude of this reduction in risk we have attempted to calculate the difference between the notional annual drought insurance premiums dryland farmers would have to pay compared to the annual premiums which would have to be paid by farmers of irrigated properties. In either case, the notional annual insurance premium has been calculated in an analogous manner to a put option. The value of the premium is related to the riskiness of what is being insured. In the following table the annual insurance premiums are calculated per $1,000 of gross revenue insured as the value of a put option[2]. We have had to abstract away from commodity price risk in the study. Therefore the insurance under investigation here only covers drought risk. The premiums are indicative only and are meant to provide estimates of relative magnitude for different farm production systems.

Table 3: Estimates of annual "drought insurance" premiums per $1,000 of annual gross revenue

	Pastoral	Arable
Irrigated	7.92	44.27
Dryland	37.53	72.18
Irrigated/dryland differential	29.61	27.91

As can be seen the notional annual premium for insuring $1,000 of dryland pastoral production is $37.53, which is $29.61 higher than the notional premium for insuring production on irrigated land. Likewise notional premiums on dryland arable production is $72.18, which is $27.91 higher than the notional premiums on irrigated arable production. These differentials give us some idea of the minimum annual value of the reduction in risk which occurs when irrigation is available. The estimates are minimums as they highlight what dryland farmers would have to pay to insure their existing levels of production. The following table summarises estimates of the reduction in risk available in the Morven-Glenavy irrigation scheme for a variety of farm classes.

Table 4: Estimates of the total annual value of risk reduction for the Morven-Glenavy irrigation scheme (1988 dollars)

Land use	Area ha	Dryland gross revenue $/ha	"Premium" differential % of gross revenue	Value of risk reduction $
Sheep	4,650	195.28	2.961	26,887
Beef	150	198.67	2.961	882
Deer	300	854.64	2.961	7,592
Dairy	1,550	733.83	2.961	33,679
Crop	1,200	945.00	2.791	31,650
TOTAL	7,850	-	-	100,690

Note: The premium differential is now the difference between the irrigated and dryland notional premiums in $ per $100 of gross revenue. The value of the risk reduction is the product of the area of land use, the gross revenue and the percentage premium differential.

[2] The insurance premiums are calculated as the value of an "at-the-money" European put option assuming a term to expiry of one year, a risk-free rate of 10 per cent and a range of standard deviations between 10 per cent and 30 per cent. The authors will supply further details of the calculation of these estimates on request.

Pastoral sheep production, dairying and cropping are the predominant land uses in the scheme. In each case the total value of the risk reduction for each class of land use is simply the percentage premium multiplied by the product of the total area of each land use and the gross revenue per unit for each land use. The total estimate of the risk reduction is $100,690 and is simply the sum of the premium reductions for each land use type. Although this estimate should be interpreted with care, it is a lower bound of the likely annual value of the reduction in risk. As it is an annual value, and given that the scheme has an ongoing life, the present value of this reduction in risk is simply the present value of an annuity for remaining life of the scheme. Assuming a 10% discount rate and 40 years of life remaining in the scheme, the present value of the annual reduction in risk would be around $985,000. For a 12% discount rate, the present value is $830,000.

SUMMARY

Project analysis always involves elements of risk in the assumptions used. Invariable recourse to subjectivity is required. The triangular distribution provides a simple and useful framework to express such risk. MAF Policy has a program called ANWA that can handle a reasonable large number of stochastic variables in a discounting cost benefit algorithm.

In choosing an appropriate discount rate, the CAPM provides an approach to measure the risk-adjusted opportunity cost of capital for an individual firm. This is the WACC which allows for systematic risk, that is, uncertainty beyond management control.

The WACC for farmers involved in the Morven-Glenavy Irrigation Scheme was estimated at between 10 and 12 percent in pre-tax real terms for the 1988/89 year. The discount rate used by Treasury to assess the valuation of irrigation assets for sale to irrigators, corresponded to a pre-tax rate of about 11%, that is, mid way between the range we have calculated.

Economically, the Morven-Glenavy Irrigation Scheme has not performed well. An ex-post analysis in 1986 derived an internal rate of return of 5.4% when the expected public returns to government's industry support investments was 10%.

In 1988, the scheme assets, along with assets of all other Crown owned irrigation schemes, were valued in terms of the marginal net benefit of continuing with, and further development of, irrigation compared to reversion to dryland farming. The process involved a valuation based on all land uses, a valuation with the predominant sheep farming land use assumed on the total irrigated area, and then further negotiated downward adjustments of the asset value. This was to isolate the value of off-farm assets. The final offer accepted by the government was $550,000. Although the smaller and older, neighbouring Redcliffs scheme was combined in with the Morven-Glenavy, the former effectively had a zero value. Financial risk exposure at the time, would have had a large influence on the irrigators' negotiating stance.

In this paper, the valuation of the scheme's asset was assessed using the ANWA. The input data used for the Crown's valuation process was simplified, and in the case of livestock carrying capacity, reduced from the potential under irrigation down to the actuals indicated by the 1986 ex-post study. Assuming all irrigated land is under sheep farming, the off-farm irrigation assets are estimated at $4.31 million (net present value at 10% discount rate) with 95 percentiles from $2.85 million to $5.77 million. At the higher discount rate of 12% - as indicated by the CAPM analysis - the estimates are $3.55 million with 95 percentiles from $2.22 million to $4.88 million. The final price agreed upon between the Crown and irrigator representatives

was about 25% of the lowest bound of our analysis. This appears to be an obvious bargain to the irrigators and a large write-off of potential asset value to the Crown.

The final part of the paper involves an application of option pricing theory to the Morven-Glenavy Scheme. The notional insurance premium figures are illustrative only. However, the relationships of variability between irrigated and dryland pastoral, irrigated and dryland arable and irrigated pastoral and irrigated arable are based on recent research. There is a reduction in production risk between dryland and irrigated land uses.

The reduction in risk adds $0.985m and $0.83m to the mean asset values at 10% and 12% discount rates, respectively. The option price for reduced risk is about 10% of the total irrigation asset value derived by ANWA. This is a significant benefit element and demonstrates the need to be aware of this in projects that exhibit characteristics of reduced risk between the without and with project outcomes.

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DO TRANSACTIONS COSTS HELP EXPLAIN THE EXISTENCE OF VARIOUS SHARE-MILKING ARRANGEMENTS

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DO TRANSACTIONS COSTS HELP EXPLAIN THE EXISTENCE OF VARIOUS SHARE-MILKING ARRANGEMENTS

Abstract:

Share-Milking has historically been a significant part of the New Zealand Dairy Industry. In recent years the economic environment in which share-milkers operate has changed significantly.

A wide stream of literature examines the efficiency and existence of share arrangements. Some literature focuses on risk aversion. Recent work considers share farming in the context of the principal-agent problem.

This paper examines whether transactions costs could explain the existence of share-milking contracts. Various forms of share-milking contracts are examined to see if they attempt to minimise transaction costs. A small group of dairy farmers are asked whether transaction costs influence the form of share-milking contract they prefer.

INTRODUCTION

Ten years ago, Maughan et al (1980) presented a position paper on sharemilking in New Zealand. The authors showed that the dairy industry had been undergoing major restructuring. In particular, the industry had been adopting labour-saving technology in order to increase output per person and so maintain farm incomes in a period of rapidly rising costs and relatively slowly rising incomes. The implications of this restructuring in terms of farm production was to reduce the number of suppliers and share-milkers, increase the size of farms and herds, and the number of cows milked per person. These trends were expected to continue.

As the following statistics show, these trends continued through the 1980's. Table 1 shows that since 1980/81, the number of dairy herds has decreased by about 1,000 herds (despite increased herds in the South Island), farm production per farm has increased by over 5,600 kg of milkfat per farm, and production per hectare has also increased.

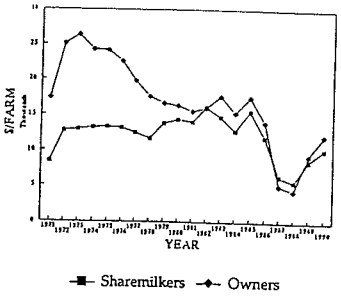
Table 1 Summary of Factory Supply Farm Statistics 1974-75 - 1990-91

Seasons	Herds	Herd Size	Production per Farm (Kg Milkfat)	Production per Cow (Kg Milkfat)	Effective Area (Hectares)	Cows per Hectare	Prodn per Hectare (Kg)	Heifer Calves per 100 cows
1974/75	16,540	112.5	14,400	128				
1975/76	16,449	114.8	15,700	137				
1976/77	15,986	116.5	16,600	143				
1977/78	15,454	120.0	15,700	131				
1978/79	15,156	123.2	17,500	142				
1979/80	14,962	126.1	19,000	151				
1980/81	14,561	128.6	18,864	147				
1981/82	14,391	132.7	19,090	144	63	2.1	310	25.5
1982/83	14,455	136.6	19,600	143	64	2.2	312	25.3
1983/84	14,612	140.2	21,618	154	65	2.2	345	28.3
1984/85	14,593	145.8	22,190	152	64	2.4	359	26.3
1985/86	14,499	149.7	23,489	157	64	2.4	379	25.8
1986/87	14,121	151.4	20,885	138	65	2.4	331	23.6
1987/88	13,772	152.9	23,500	154	65	2.4	374	23.0
1988/89	13,593	157.3	22,442	143	66	2.4	340	24.3
1989/90	13,357	160.3	23,578	147	67	2.4	352	25.3
1990/91	13,420	165.8	24,495	148	70	2.4	351	26.1

Source: Dairy Statistics 1990/91

Real net dairy farm incomes have continued to decline over the 1980's. Figure 1 compares the real net farm incomes for New Zealand share-milkers and Waikato owner-operators. The gap between owner operator incomes and share-milker incomes has nearly been completely eroded over the time period considered.

Figure 1 REAL NET INCOMES (Real or Constant 1980 Dollars)



Source: Scrimgeour (1992)

As Table 2 shows, share-milkers on average, milk larger herds than owner-operators. Share-milkers produce more milk fat per herd with a similar per cow performance compared to owner-operators.

Table 2 Production of Owner-Operators and 50/50 Sharemilkers

	Owner Operators	50/50 Sharemilkers
Number of Farms	9,220	3,140
Effective Area (Ha)	61.4	79.3
Average Herd Size	159.6	189.5
Milkfat per Herd (Kg)	23,934	27,684
Milkfat per Cow (Kg)	149.5	146.4
Milkfat per Hectare (Kg)	389.9	349.2
Cows per Hectare	2.6	2.4

Source: Dairy Statistics 1990/91

During the last 15 years, the number of share-milkers in absolute and proportionate terms has increased. This is shown in Table 3. Between 1977/78 and 1990/91, the number of factory supply share-milkers has increased by 300, while the number of factory suppliers has decreased by nearly 3,000. Share-milkers now comprise 31 percent of factory supply dairy farmers compared to 24 percent fifteen years ago. This trend is opposite to what Maughan expected to happen 10 years ago.

Table 3 Operating Structures of New Zealand Dairy Farms

	1973/74		1977/78		1990/91	
	number	%	number	%	number	%
Owner Operators	14,548	78	12,228	76	9,220	68.7
Share-milkers:						
29%	204	1.1	211	1.3	322	2.4
39%	703	3.8	501	3.1	146	1.1
50%	2,708	14.8	2,412	15.0	3,140	23.4
Other Share-milking			539	3.3	467	3.4
Contract	417	2.2	171	1.1	130	4.0
Total Sharemilking	4,032	21.7	3,898	24.2	4,200	31.3
Total Suppliers	18,580		16,126		13,420	

Source: Maughan et al (1980) Dairy Statistics 1990/91 (1992)

The question is why dairy farm owners increasingly continue to choose to use share-milkers as a form of labour contract, in the face of declining real net incomes as shown, when it would appear more profitable to retain ownership of the herd and employ labour on other than a sharemilking basis.

DESCRIPTION OF SHAREMILKING CONTRACTS

Sharemilking involves operating a farm on behalf of the farm owner, for an agreed share of the farm receipts. Three types of sharemilking agreements are commonly used; 29 percent, 39 percent and 50 percent.

Under the 50 percent agreement, the share-milker owns the herd and any plant and equipment (other than milking plant) needed to farm the property, although the owner usually pays for farm improvements. The share-milker and the farm owner each receives 50 percent of the farm receipts.

Unlike the 50 percent agreement, where the owner may have little to do with farm management, the 39 percent and 29 percent agreements often see the owner heavily involved in farm management. The 39 percent agreements involve the farm owner retaining ownership of the herd. The share-milker carries out all farm work and in return receives 39 percent of the milk receipts. The 29 percent agreement is similar except that the share-milker is usually responsible for herd management and the owner is responsible for most of the other farm work. The owner bears more of the farm costs, such as hay-making and farm vehicle running costs.

Contract milkers are contracted to milk a herd at a set price per kilogram of milkfat produced. The actual rate is set according to the amount of farm work done.

Until 1990, 29 percent and 39 percent sharemilking contracts were covered by specific legislation. Under the Sharemilking Agreements Order 1990, all sharemilking contracts are no longer specifically covered by government legislation. Any new agreements can only be altered if the share-milker is not disadvantaged by the change. The agreed percentage split of income and expenses is completely negotiable. In practice, variations occur with either the share-milker in return for sharing animal health costs, takes a share in stock sales and supplements, or the owner pays all animal health costs and the share-milker receives no share in stock sales or supplements.

THE THEORY OF SHAREFARMING

Sharemilking is a form of sharefarming or share tenancy. Sharefarming has long persisted in agrarian economies, and until relatively recently was considered an inefficient allocation of resources. Cheung (1968) demonstrated that economic efficiency is the same under various land tenure arrangements subject to the constraint of private property rights and zero transaction costs. A broad stream of literature has followed developing a modern theory of agricultural contracts, e.g. Cheung (1969), Newbury (1977), Stiglitz (1974), Lucas (1979). Although far from complete, the theory is based upon a trade-off between the transaction costs associated with a given contract and the risk premium needed to get parties to enter that contract, Hoffman (1984), Cheung (1969).

The transaction costs which fall upon landowners include the costs of negotiating and enforcing the contract and of ensuring that the tenant or labourer meets their side of the bargain. The landowners transaction costs are higher for labour contracts, for in addition to keeping the labourer from misusing the property, the landowner has to supervise the labourer to make sure the labourer furnishes the amount of labour specified in the contract. With perfect information and no uncertainty, the landowner could observe the labourers effort directly or infer it from agricultural output. But in the real world, the landowner has to pay to discover how hard the labourer is working, and monitor the labourer in order to prevent shirking. The transaction costs are somewhat lower for sharefarming, because the sharefarmer has some incentive to work.

The landowner still has to supervise the sharecropper to a certain extent because the sharefarmer's receive only a fraction of their marginal product and hence have reasons to undersupply labour. Transactions costs are lowest for fixed-rent contracts, for renters receive their full marginal product and therefore have no reason to shirk. The landowner need only insure that the tenant does not ruin the property.

What keeps landowners from offering nothing but fixed-rent contracts with their low transaction costs is the premium which they must offer risk-averse tenants in order to induce them to accept the uncertainties of paying a fixed rent. The premium is lower for share contracts because sharefarmers absorb only a fraction of the risk. Since there is little or no risk attached to a fixed wage payment, the landowner need offer no premium in order to engage farmhands. The mix of contracts is then determined by the balance between transaction costs and risk premiums.

If transaction costs increase (other things being equal) then we would expect landowners to shift from wage contracts towards sharecropping and renting. Rental contracts would also become preferable to share arrangements. In each case, more landowners would prefer to pay risk premiums to tenants rather than to face the higher transaction costs, and the resultant change in the supply of contracts would shift the contractual mix. The reverse would be true if transaction costs dropped. The hypothesis, therefore, is that an increase in transaction costs during the 1980's has resulted in a shift in the labour contractual mix on dairy farms from wage contacts to various forms of share contracts.

SOURCES OF TRANSACTION COSTS

Various studies have investigated the sources of transaction costs. Empirically, supervision costs have been shown to be the most powerful explanatory variable among transaction costs, e.g. Higgs (1974), Alston (1981), Alston and Higgs (1982). Cheung (1969) ascribes the sources of transaction costs to differences in the physical attributes of input and output, different legal arrangements, and different market arrangements.

According to Williamson (1985), transaction cost economics characterises human nature as we know it by reference to what he terms bounded rationally and opportunism. With bounded rationality, economic actors are assumed to be intendedly rational but only limitedly so, Simon (1961). If mind is the scarce resource, then economising on claims against it is plainly warranted, Simon (1968). Economising on bounded rationality takes two forms - one concerns decision processes and the other involves governance structures (contractual arrangements). Transaction cost economics is principally concerned with the economising consequences of assigning transactions to contractual arrangements in a discriminating way. *Ceteris paribus,* modes of governance structures that make large demands against cognitive incompetence are relatively disfavoured, Williamson (1985).

Opportunism is defined as self-interest with guile, Williamson (1985). It often involves subtle forms of deceit - both active and passive forms, both ex ante and ex post. Transactions that are subject to ex post opportunism will benefit if appropriate safeguards can be devised ex ante.

Williamson proposed that with these causes of transaction costs, transactions can be arranged according to the degree of:

(i) asset specificity involved in the transaction;
(ii) the degree of uncertainty; and
(iii) the frequency of the transaction.

An asset is transaction specific if it cannot be productively redeployed in other uses since it's value is higher to the contracting parties than it's value in it's next best alternative use. Frequency refers to the number of transactions that occur within a contractual arrangement. Uncertainty recognises that there are costs involved in discovering information about prices, qualities and outcomes, that those costs increase with increasing uncertainty, and that the information is not likely to perfect ex ante.

The relative importance of these dimensions will then determine the type of contract that attempts to economise on bounded rationality and opportunism. Thus the greater the specificity of the asset (both physical and human) the greater is the influence of bounded rationality and the prospect for opportunism, thus the more complex is the governance structure needed. Similarly, where uncertainty is increased, the more important it is for the parties involved to devise a contractual arrangement that allows "things to be worked out", as it is impossible to specify all contingencies in advance. The cost of specialised governance structures will be easier to recover for large transactions of a recurring kind.

In extending this analysis to share-milking, wage contracts will assume importance when asset specificity, uncertainty or frequency is low. More complex labour contracts will be needed as these dimensions assume greater importance.

WHAT DAIRY FARMERS THINK

A small number of dairy farmers in the Waikato were approached in order to establish their views on the influence of transaction costs in their choice of labour contracts. The interview was in the form of an informal, but structured, discussion rather than a questionnaire. The nature of transaction costs were first discussed so that the farmer concerned had an understanding of the term. Farmers were then asked about why they chose the form of labour contract they presently have and what reasons they may have had to change the form of their labour contracts in the past fifteen years. Some discussion on future plans also ensued.

Although all the farms concerned were similar with respect to the nature of the production system (factory supply dairy farms, on similar land around Hamilton), each farmer differed in some important aspect that affected the choice of labour contract. In particular, with farms recently acquired or extended, the farmer involved could not afford to employ labour other than wage labour. Somewhat related to this, the younger farmers seemed to prefer the closer control that a hands-on management approach implies. The relative proportions of the dairy farmers major imputs - labour, capital and management - therefore varies with the stage of development of the family farm unit.

Despite these differences, some observations appeared to be common amongst the farmers approached. These observations tend to support the transactions cost approach to the choice of contract arrangement. With a more rigorous pattern of interviewing, these observations may prove to be confirmed for a wider sample of farmers. The observations offered follows.

Frequency of Transaction

Farmers recognise the value labour adds to their production system. Most farmers interviewed volunteered they were poor selectors of labour, and were concerned about the downside costs in lost production if the wrong person was employed. A more complex contract than a wage contract is therefore justified because it is an important transaction of a recurring kind. Although difficult to generalise because of differing farmer circumstances, it is possible that this dimension of frequency of transaction has assumed more importance because the downside costs of employing the wrong person is greater now than when there was more support for the industry through SMP's and government guarantee of Dairy Board Funds. Also, an increase in the unemployment rate has resulted in more job applications for those looking for a job rather than a career in the dairy industry. A share-milking contract therefore offers an efficient mechanism to screen job applicants.

Uncertainty

Farmers freely acknowledge their dislike of supervising labour. Share-milking is seen by farmers as freeing them from supervision - as the problem is passed onto the share-milker. Two reasons were suggested as to why supervision costs may have increased. One reason suggested is increased farm and herd size and more farmers owning more than one farm has raised supervision costs to the extent that a share-milking contract is a more efficient contractual arrangement. Another reason suggested is with more people seeking employment in the dairy industry, offering share-milking contracts reduces uncertainty by screening for those employees who have demonstrated some motivation to progress in the dairy industry.

All the farmers interviewed had been through the industry and economy-wide downturn of the mid-late 1980's. These farmers generally look back on this experience with favour, rather than regret, as the experience forced reappraisal of the nature and purpose of the venture they were engaged in.

Farmers interviewed believed they now place a higher value on the quality of life and the quality of family life than they did earlier in the 1980's. The farms were thus organised to enable them to meet these goals. A share-milking contract enables these farmers to be absent from the farm for periods they choose, in the knowledge that the business is in the hands of capable, motivated employees.

Also, the farmers interviewed, rate dairy farming as a less risky investment than investments outside the farm than they did before the downturn. One comment for instance was that unlike office blocks there were no empty dairy farms. In the light of this experience, farmers perceive that the risk premium they need to pay share-milkers is less than the risk premium they are prepared to accept for investments elsewhere.

Increased Asset Specificity

It was frequently mentioned in interviews that there is a more than proportionate increase in farm management ability needed when increasing herd numbers from say 400 cows to 800 cows than from 200 cows to 400 cows. Farmers with large farms thus recognise the human capital needed to manage large herds. This expertise was often better held with a share-milker who specialised in large herd management than held by the landowner concerned. The increase in the size of herds requiring increased management ability may thus help explain increased share-milking contracts.

CONCLUSION

In this paper it is suggested that the mix of sharefarming contracts is largely determined by the transaction costs. An increase in transaction costs (other things being equal) results in a shift from wage contracts towards sharefarming and renting. In doing so, landowners prefer to pay risk premiums to sharefarmers or tenants than face the higher transaction costs associated with wage contracts.

In examining the causes of transaction costs, the work of Williamson seems relevant to an agricultural situation. Although not used in a sharefarming context before to this writers knowledge, the arrangement of transactions and contracts according to asset specificity, uncertainty and frequency that minimises transaction costs helps explain why the proportion of share-milking contracts in New Zealand have increased during the 1980's. In particular, the increase in the size of herds raises the prospect of increased transaction costs, hence a preference towards share-milking contracts.

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